NUTRITION ATLAS OF INDIA

C. GOPALAN
K. VIJAYA RAGHAVAN

NATIONAL INSTITUTE OF NUTRITION
(Formerly Nutrition Research Laboratories)
Indian Council of Medical Research
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APPENDIX

INTRODUCTION

During the last two decades a great deal of valuable information pertaining to the nutritional status of Indian population groups has been collected. This valuable material has been scattered in several publications and has not been collectively presented.

This Nutrition Atlas is an attempt at the compilation of this valuable material. In the year 1964, a Diet Atlas setting out valuable information on the dietary patterns in different parts of the country was prepared. This publication attracted considerable attention and has in fact been re-written and brought up-to-date. It is hoped that this Nutrition Atlas will prove equally popular and useful.

The material presented here is mostly based on the investigations carried out in the Nutrition Research Laboratories. Some data collected from other centres working on specific projects under the auspices of the Indian Council of Medical Research have also been included. The actual sources of these data have been acknowledged in the text.

It is hoped that this publication will serve the purpose of highlighting the major nutritional problems in our country and would thus prove valuable in the formulation of public health nutrition programmes.

The major nutritional problems of the country have been presented in pictorial or diagramatic form in the Atlas. For the convenience of those who may desire further details, tables setting out the detailed data have been included.

Apart from Dr. K. Vijaya Raghavan, Dr. S. G. Srikantia, Dr. M.C. Swaminathan and the Statisticians, specially Mr. D. Vasudeva Rao, have helped in the compilation of this Atlas and I wish to gratefully acknowledge their co-operation.

(C. Gopalan)
Director.

NUTRITIONAL STATUS OF PREGNANT AND LACTATING WOMEN

NUTRITIONAL DEFICIENCY SIGNS IN PREGNANT WOMEN PERCENTAGE PREVALENCE

Women of child bearing age (15 - 45 years) represent 21.2 % of our population. At a given time, it is estimated that there are 20 million pregnant women. The majority of them belong to the poor socio-economic group.

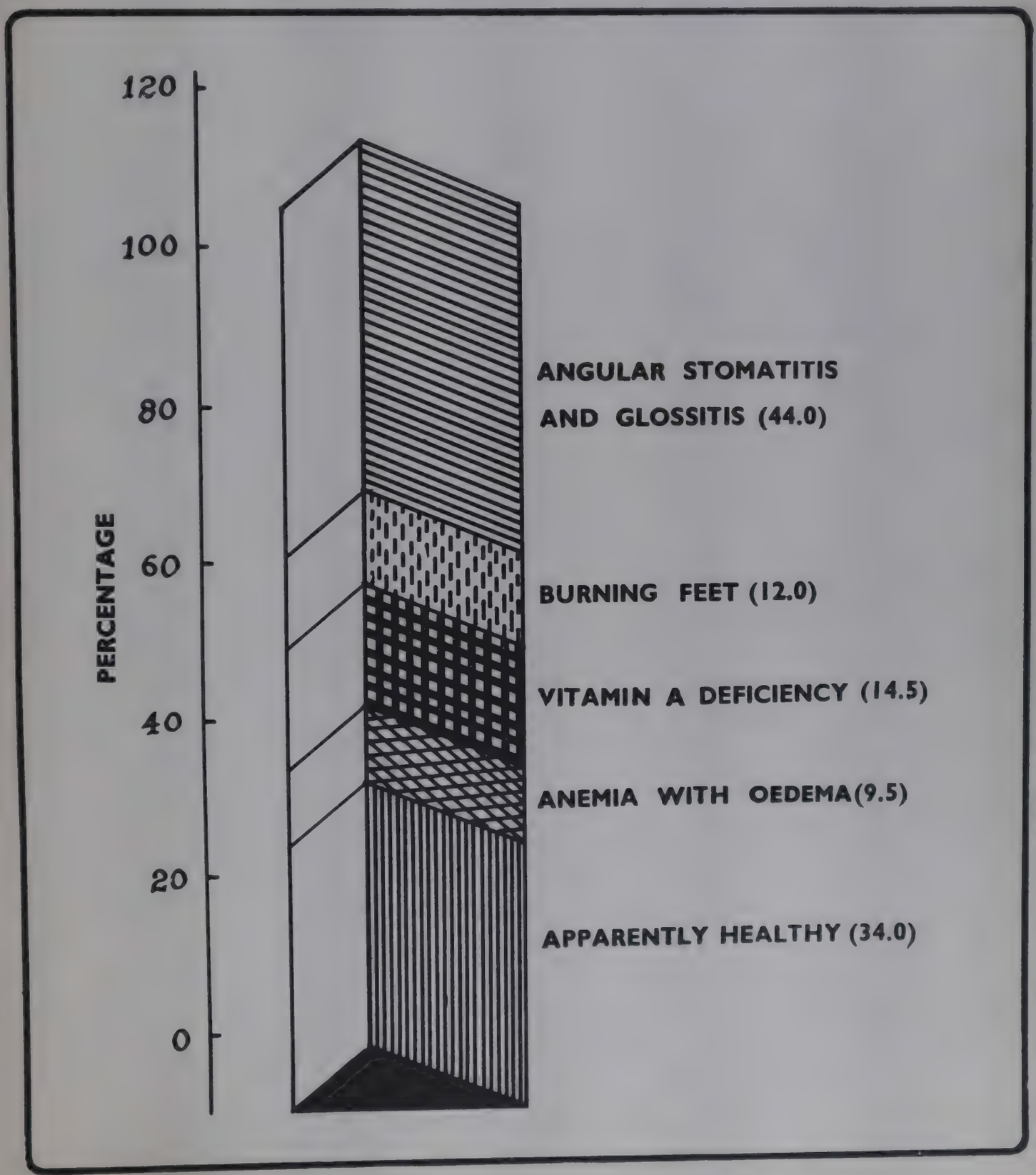
Surveys indicate a high incidence of malnutrition among pregnant women of the poor economic group. Maternal malnutrition is responsible not only for high maternal mortality but is also an important factor in influencing the nutritional status of the offspring.

The common manifestations are glossitis, angular stomatitis (inflammation of tongue and angles of the mouth) and paraesthesias like burning-feet and pins and needles in the limbs arising from B-Complex deficiencies. A large number of cases of anæmia are also encountered among expectant mothers.

Of the pregnant women examined in this survey carried out in South India only 34 % were apparently healthy. The rest showed various signs of malnutrition.

Source : Gopalan. C. (1957). *J. Trop. Paediatrics*, 3:3.

NUTRITIONAL DEFICIENCY SIGNS IN PREGNANT WOMEN PERCENTAGE PREVALENCE

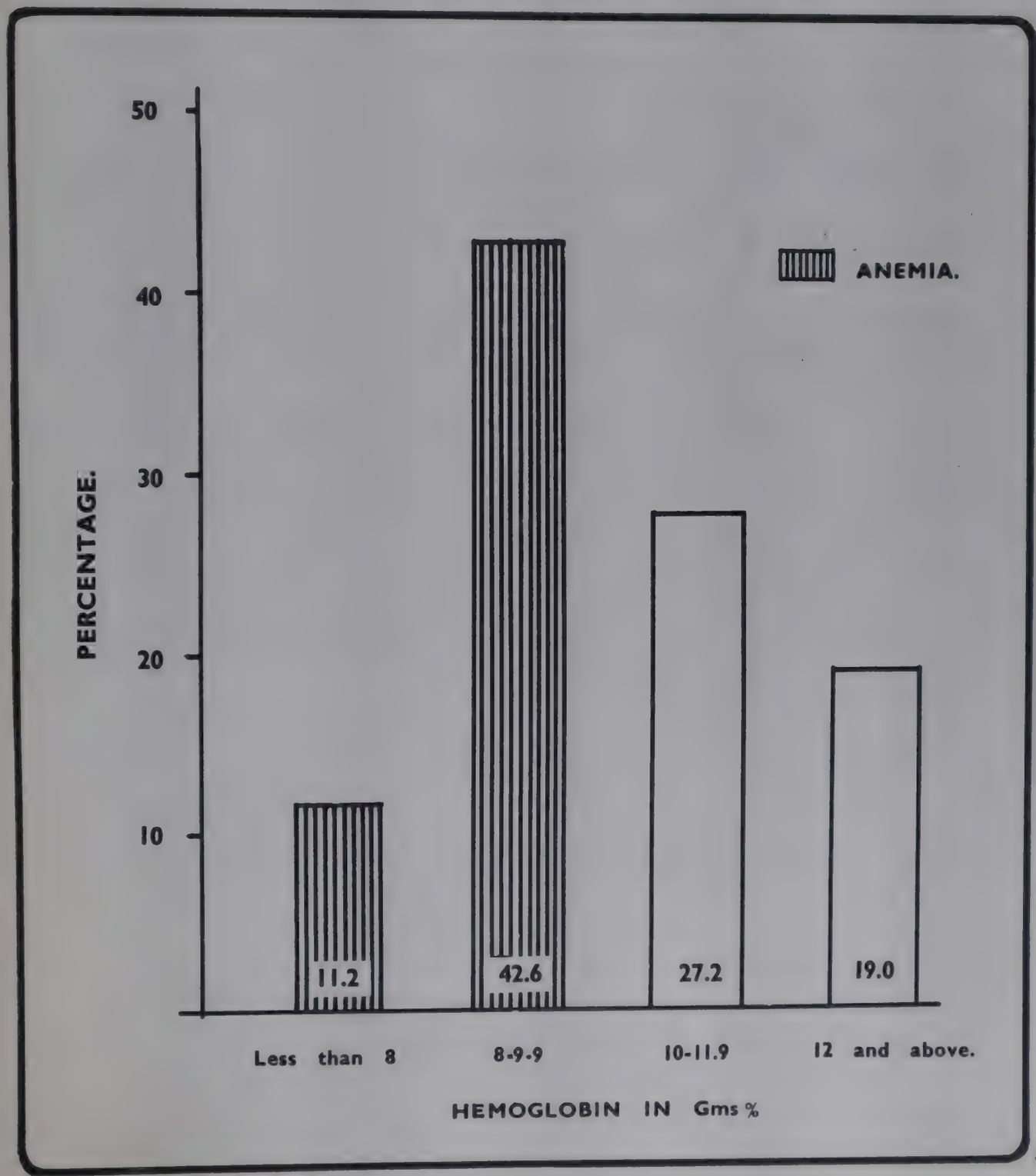


PERCENTAGE DISTRIBUTION OF HAEMOGLOBIN LEVELS IN PREGNANT WOMEN

Nutritional anæmia is a major public health problem in India, particularly among expectant mothers. Hæmoglobin estimations carried out in various parts of the country in pregnant women show that about 54% of them are anæmic, i.e., they have hæmoglobin levels below 10 g%. There is evidence that iron deficiency is largely responsible for this.

These data are compiled from hæmoglobin estimations done on about 8,000 pregnant women in different parts of the country.

PERCENTAGE DISTRIBUTION OF HAEMOGLOBIN LEVELS IN PREGNANT WOMEN



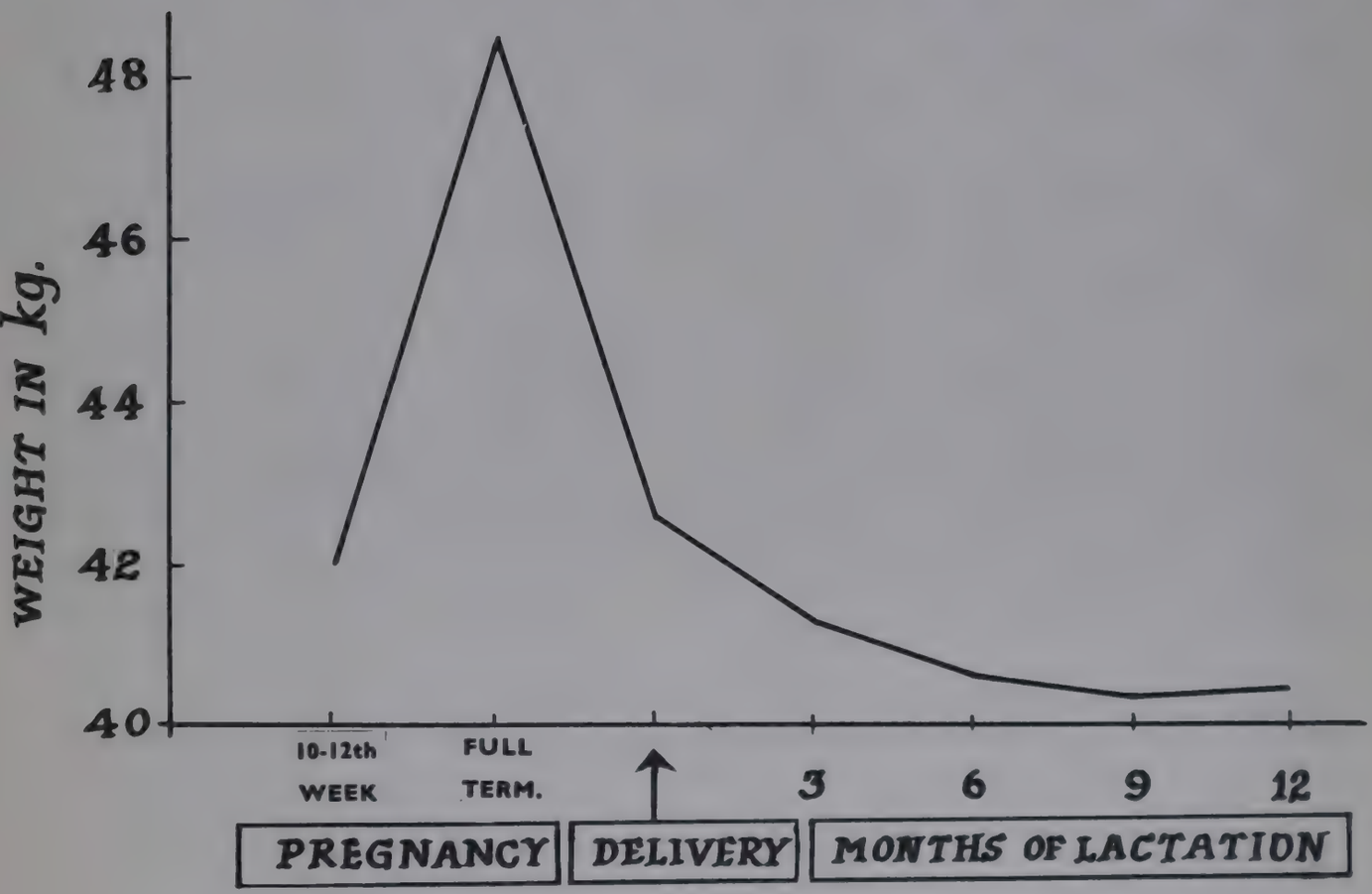
WEIGHT CHANGES DURING PREGNANCY AND LACTATION

Between conception and confinement, every pregnant woman faces many hazards and becomes vulnerable to nutritional stress.

A follow up of expectant mothers reveals that on an average, an Indian mother of low income group gains about 6.7 kg during pregnancy when compared to about 10 12 kg in Western mothers.

Source : Annual Report, Nutrition Research Laboratories, 1965–66.

WEIGHT CHANGES DURING PREGNANCY AND LACTATION



VOLUME OF BREAST MILK SECRETED BY POOR INDIAN MOTHERS

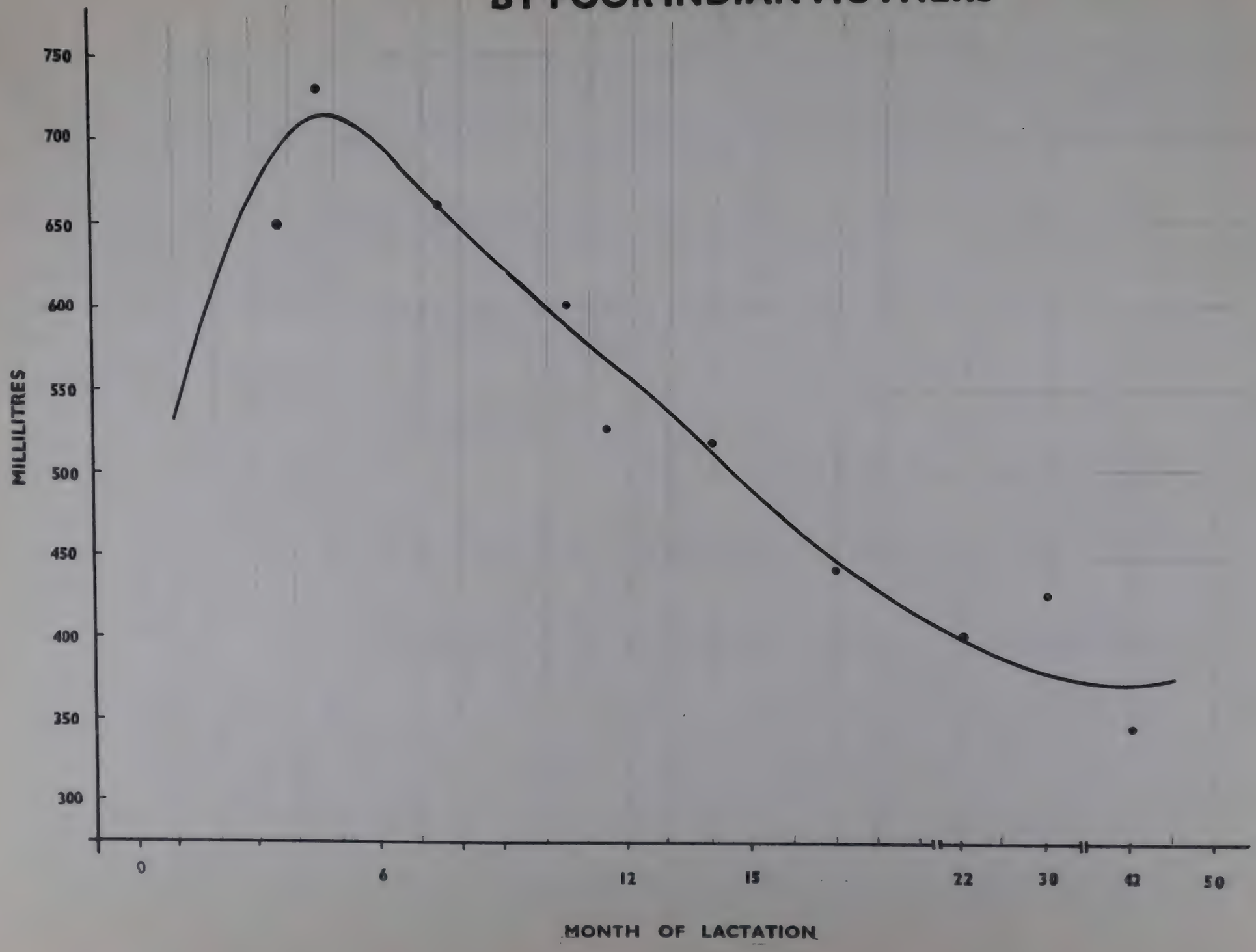
A great asset in our present nutritional situation is the remarkable ability of the poor Indian mother to breast feed her infant for prolonged periods, sometimes extending to nearly two years. But for this, the picture regarding the nutritional status of our poor infants and children would be much worse than what it is to-day.

Since breast milk generally forms the only source of dietary protein for poor Indian infants in the first two years of life, information on the volume and composition of human milk is important.

Longitudinal and cross-sectional studies indicate that poor Indian women secrete as much as 400–600 ml of milk daily during the first year. The volume of breast milk secreted may suffice to meet the nutritional requirements of the child until the sixth month, but later on breast milk alone will not be enough to meet the nutritional needs of the growing child. Supplementation has to be instituted after the sixth month to prevent protein-calorie malnutrition and its complications. Unfortunately this is not done in most poor communities, partly due to poverty and partly due to ignorance.

Source: Gopalan, C. (1958). *J. Trop. Paediatrics*, **4**: 87.
Someswara Rao, K., Swaminathan, M.C., Swarup, S. and Patwardhan, V.N. (1959). *Bull. Wld. Hlth. Org.* **20** : 603.

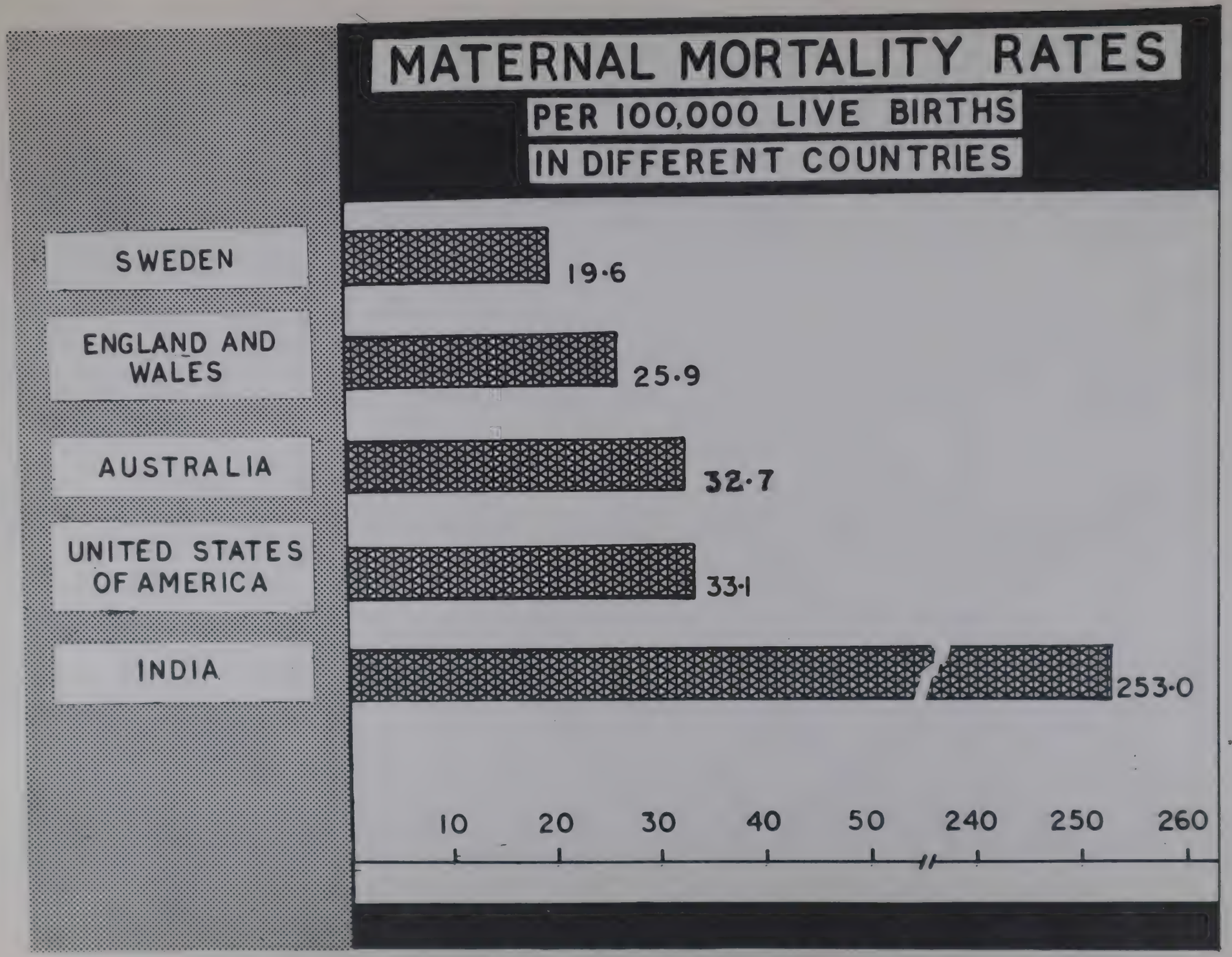
VOLUME OF BREAST MILK SECRETED BY POOR INDIAN MOTHERS



MATERNAL MORTALITY RATES PER 100,000 LIVE BIRTHS IN DIFFERENT COUNTRIES

A major cause for the high maternal mortality in our country is maternal malnutrition. Ten to twenty percent of maternal deaths are known to be due to nutritional anæmias. Maternal malnutrition is also known to affect the condition of the offspring.

Source : *Vital Statistics of India* (1963-64).
Roma N. Chamberlain (1969). *British Medical Bulletin*, **24**:87.


MATERNAL MORTALITY RATES
PER 100,000 LIVE BIRTHS
IN DIFFERENT COUNTRIES
SWEDEN
19·6
ENGLAND AND WALES
25·9
AUSTRALIA
32·7
UNITED STATES OF AMERICA
33·1
INDIA
253·0
10
20
30
40
50
240
250
260

NUTRITION IN INFANCY

MEAN BIRTH WEIGHTS IN VARIOUS PARTS OF INDIA

Average birth weight of Indian infants calculated from the observations made in the different parts of India is about 2.8 kg. There does not appear to be any significant difference in the average birth weights of infants in different regions of the country.

MEAN BIRTH WEIGHTS IN VARIOUS PARTS OF INDIA

Numbers Indicate Birth weight in Kg.

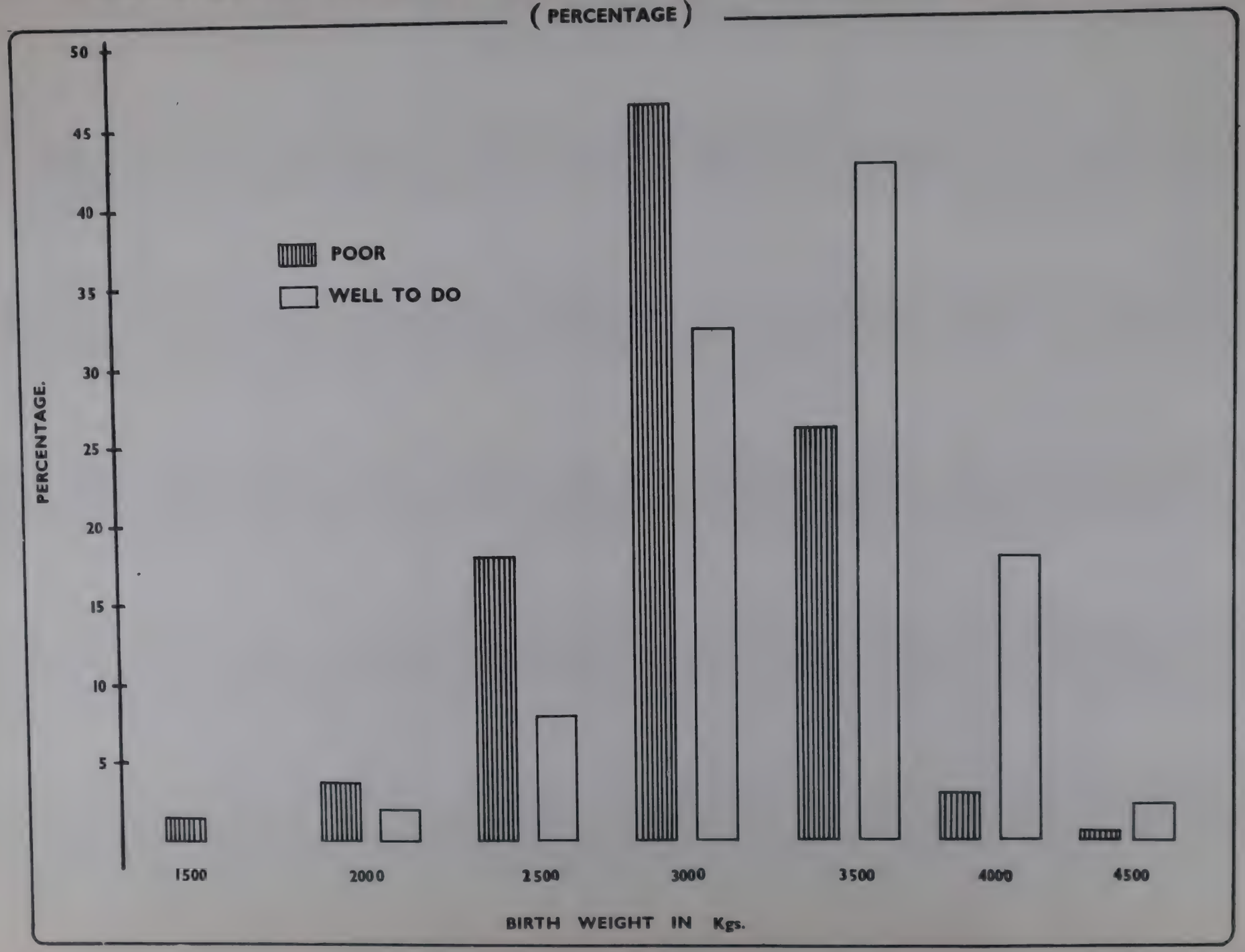
Figures in the PARENTHESES indicate number of observations.

DISTRIBUTION OF INFANTS ACCORDING TO BIRTH WEIGHTS AND ECONOMIC STATUS

The birth weights of infants born to mothers belonging to the poor socio-economic group are generally less than those of infants born to mothers of high socio-economic status. Of the factors determining birth weights, maternal nutritional status is of great importance. The poor state of nutrition of the low socio-economic group mothers is reflected in the low birth weights of their offsprings.

These results are based on surveys conducted in various parts of the country.

DISTRIBUTION OF INFANTS ACCORDING TO BIRTH WEIGHTS AND ECONOMIC STATUS



CUMULATIVE FREQUENCY DISTRIBUTION OF BIRTH WEIGHTS
FREQUENCY DISTRIBUTION OF BIRTH WEIGHTS

Frequency distribution of birth weights of well-to-do and poor Indian children shows a shift of the curve to the right in the case of well-to-do children. In other words, the well-to-do children are heavier at birth when compared with their counterparts from the low income group.

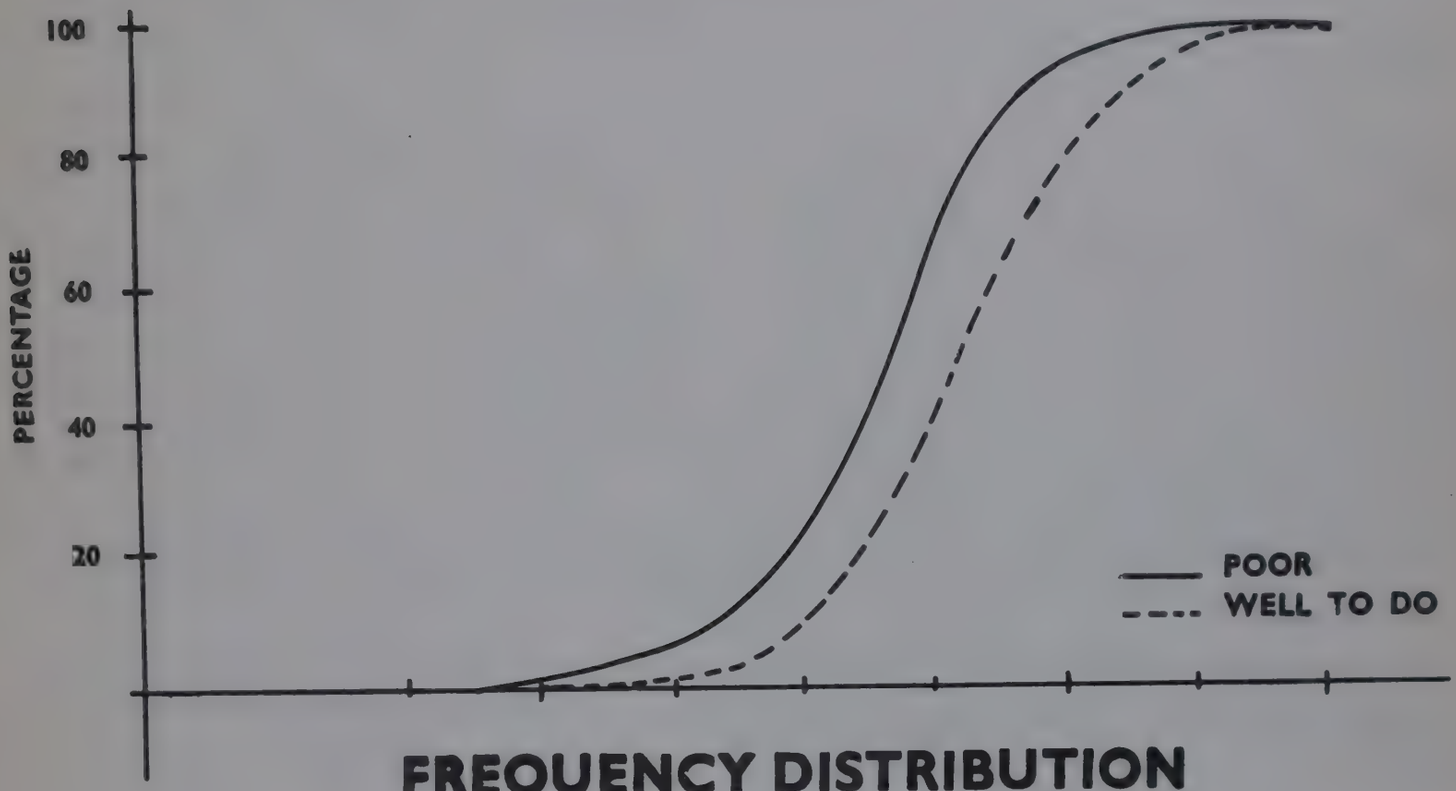
A cumulative frequency distribution of birth weights of children of the two income groups reveals that while 22 % of poor Indian children have birth weights below 2.5 kg, only about 10 % of well-to-do children have birth weights below 2.5 kg.

According to standards set by international organizations, an infant whose birth weight is below 2.5 kg is considered premature.

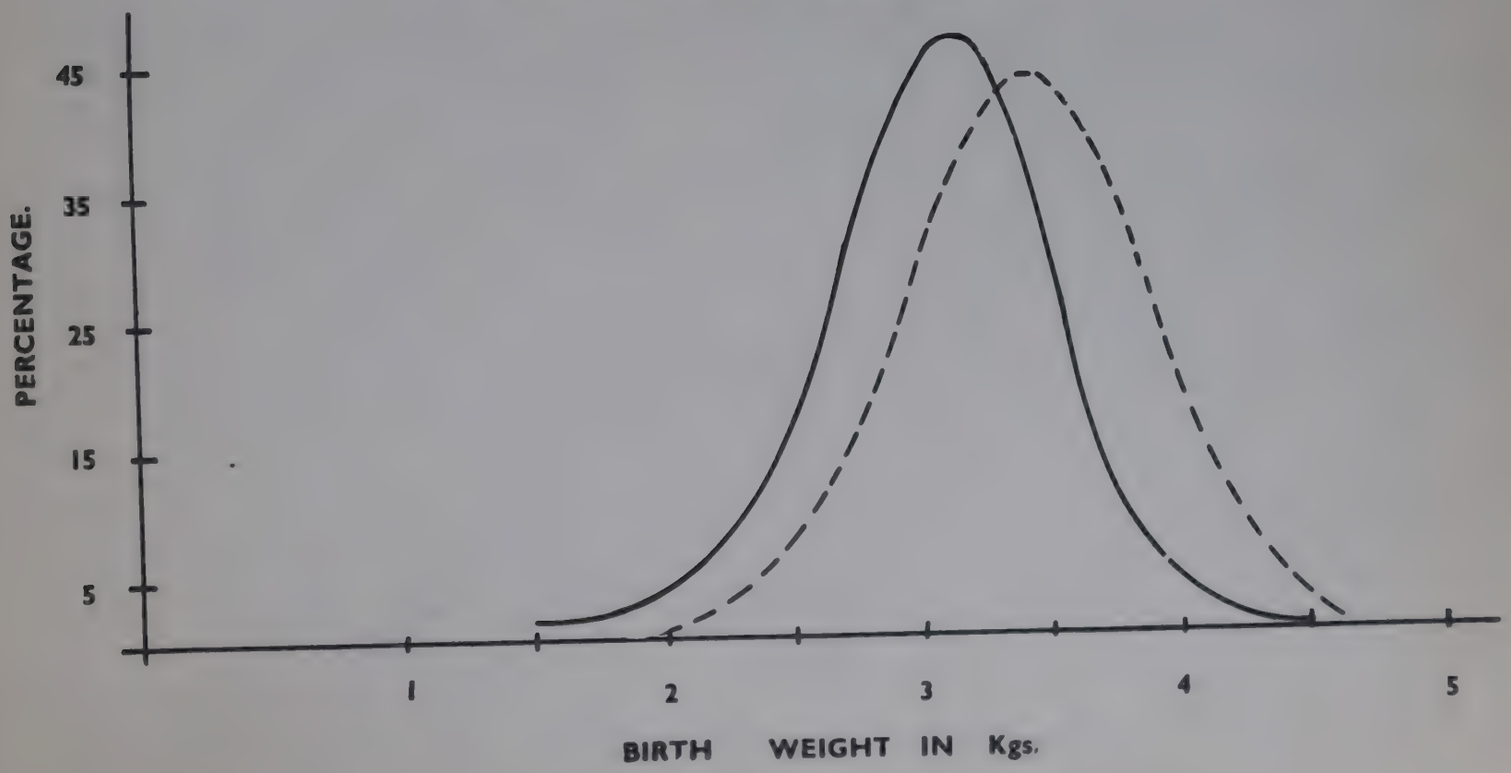
The 50th percentile (which corresponds to the mean) of well-to-do children is about 3.1 kg and that of poor children is only about 2.7 kg.

These data are compiled from a number of surveys conducted in various regions of the country.

CUMULATIVE FREQUENCY DISTRIBUTION OF BIRTH WEIGHTS



FREQUENCY DISTRIBUTION OF BIRTH WEIGHTS



INFANT MORTALITY RATES IN DEVELOPED AND DEVELOPING COUNTRIES

Infant mortality rate has been considered as an index of the general state of public health of a community. Though there has been a considerable decline in infant mortality rates in the last two decades, the present level is still much higher than that obtaining in the technologically advanced countries like Sweden, Japan, United States of America and Australia.

Available evidence indicates that malnutrition is an important factor concerned in the high infant mortality rates in developing countries.

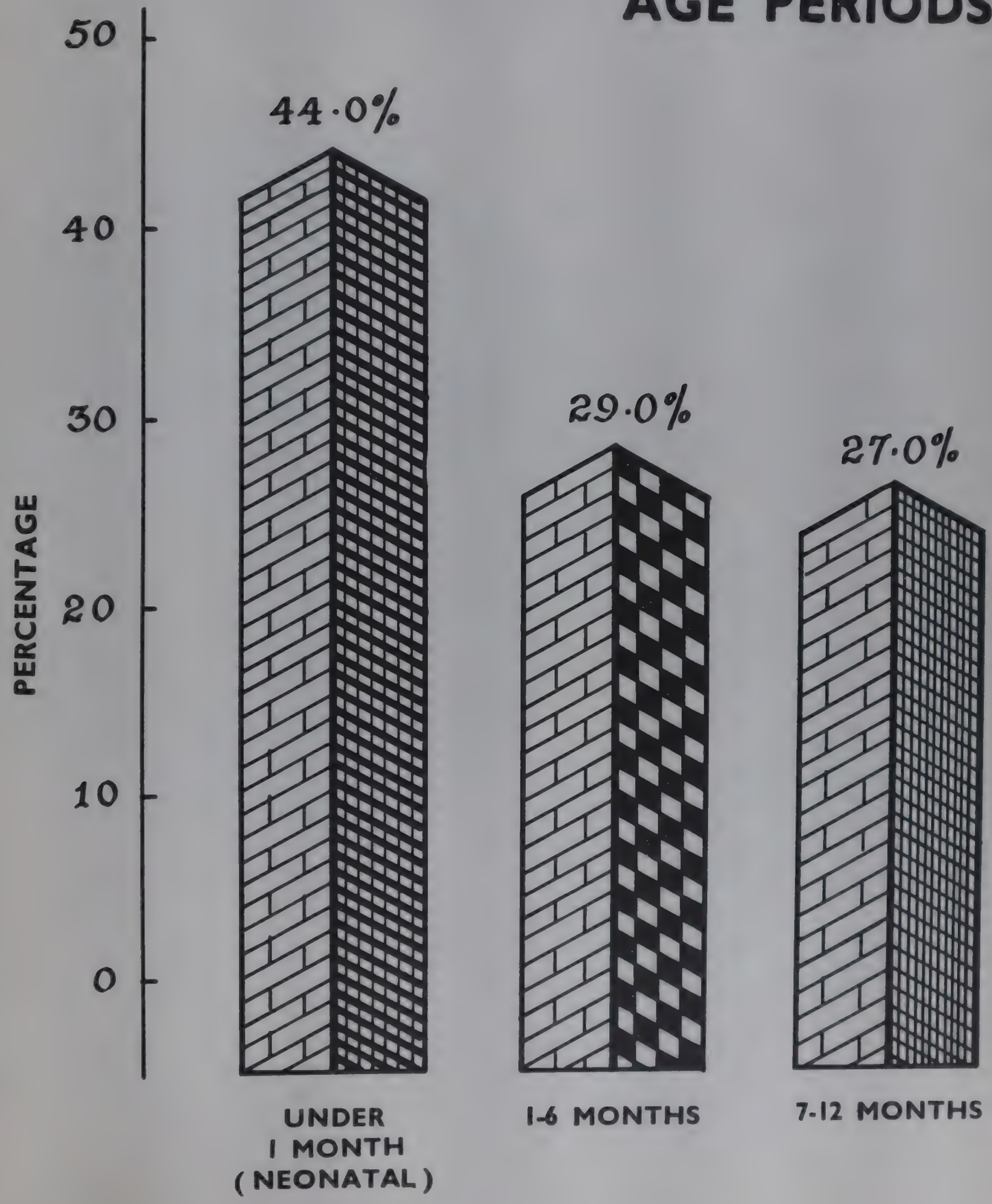
INFANT MORTALITY RATES IN DEVELOPED AND DEVELOPING COUNTRIES

PERCENTAGE OF INFANT DEATHS IN DIFFERENT AGE PERIODS

A considerable proportion of infant deaths in India occurs in the neonatal period i.e., under 1 month of age. About 45 % of infant deaths occur within the first month after birth. A major factor that contributes to such high neonatal mortality is the poor state of viability of the infant arising from maternal malnutrition.

Source: *Vital Statistics of India*, 1962 (p. XVI).

PERCENTAGE OF INFANT DEATHS IN DIFFERENT AGE PERIODS



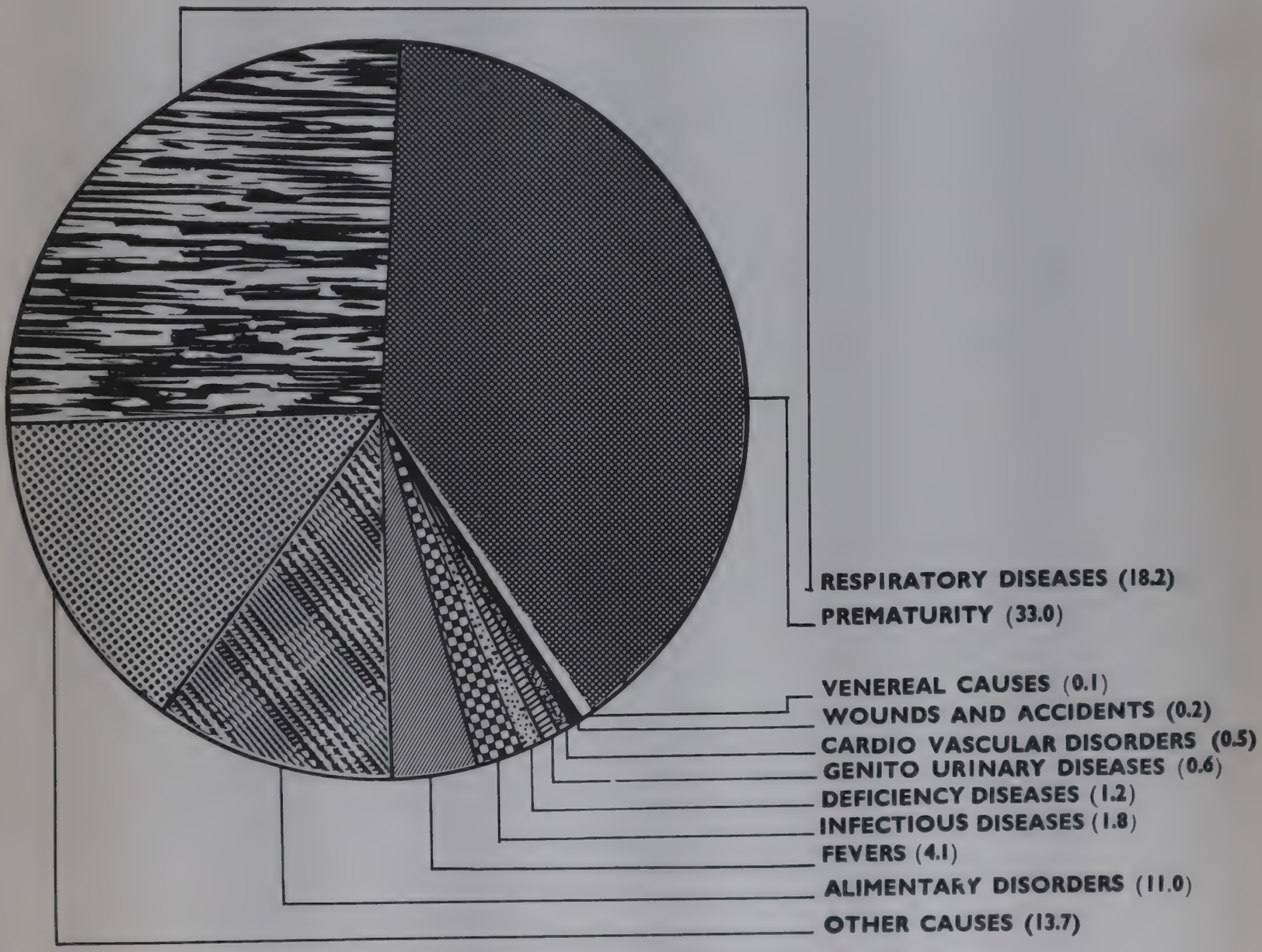
CAUSES OF INFANT MORTALITY

Causes of infant mortality are many. A detailed classification of infant deaths according to cause indicates that about 1/3 (33%) of them are due to prematurity. Maternal malnutrition is an important factor in prematurity.

Though deficiency diseases are reported to be responsible for about 1% of infant deaths, in reality the figure is much higher, since many infant deaths are associated with other non-nutritional causes like alimentary disorders and respiratory infections and classified as such.

Source : Based on *The Report of the Health conditions in Madras State* published by Government of Madras (1961).

CAUSES OF INFANT MORTALITY



FIGURES IN PARENTHESES INDICATE PERCENT

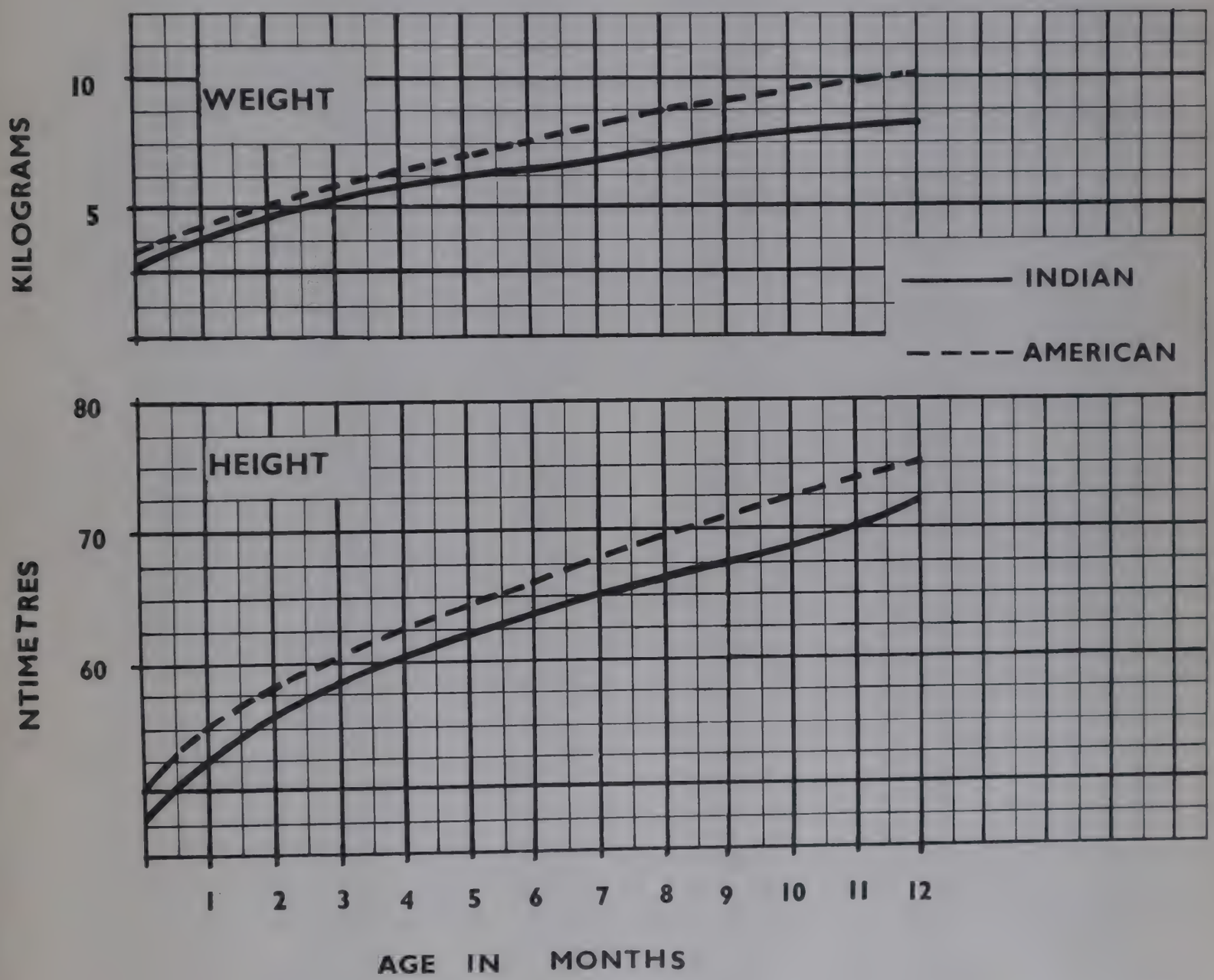
GROWTH OF INFANTS - MALES

The growth rate of the Indian infant runs parallel to that of the American infant in the first four to six months. After this age, however, the growth rate of the Indian infant falls off.

The data presented here were collected from different parts of India under the auspices of the Indian Council of Medical Research on 4,300 male infants representing a cross-section of the Indian community.

Reference : *Growth and Physical Development of Indian Children*, Part 1-A, Indian Council of Medical Research.

GROWTH OF INFANTS-MALES

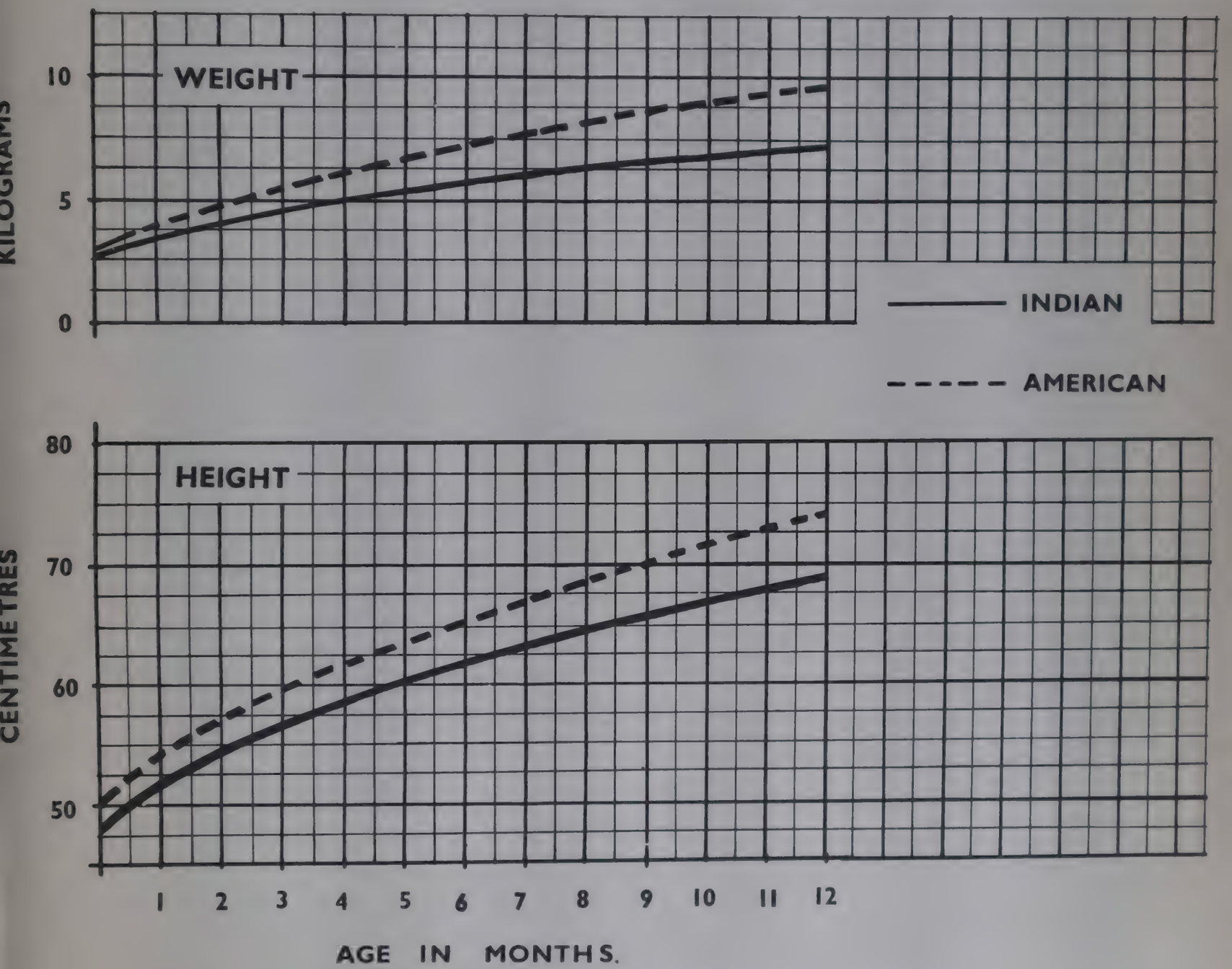


GROWTH OF INFANTS - FEMALES

As in the case of male infants, females, though they grow as well as American infants up to 4-6 months, their rate of growth falls off after that age.

Based on the surveys carried out on about 4,000 female infants under the auspices of the Indian Council of Medical Research.

GROWTH OF INFANTS-FEMALES



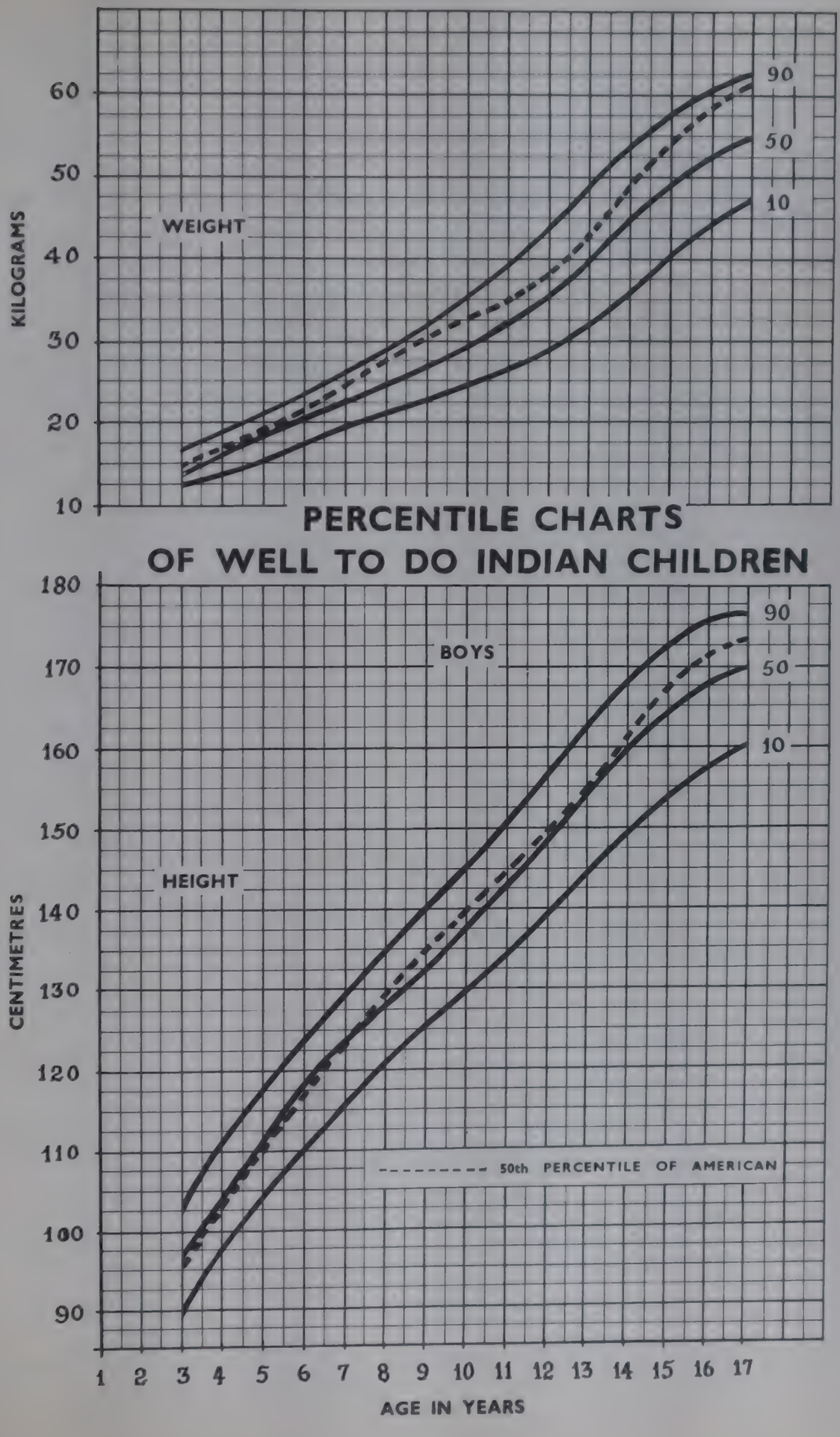
GROWTH AND DEVELOPMENT OF WELL-TO-DO INDIAN CHILDREN

PERCENTILE CHARTS OF WELL-TO-DO INDIAN CHILDREN-BOYS

Data with regard to growth and development in a large number of healthy normal children in the community in whom constraints imposed by malnutrition and infection do not operate, will provide important data which can be used as standards to be achieved.

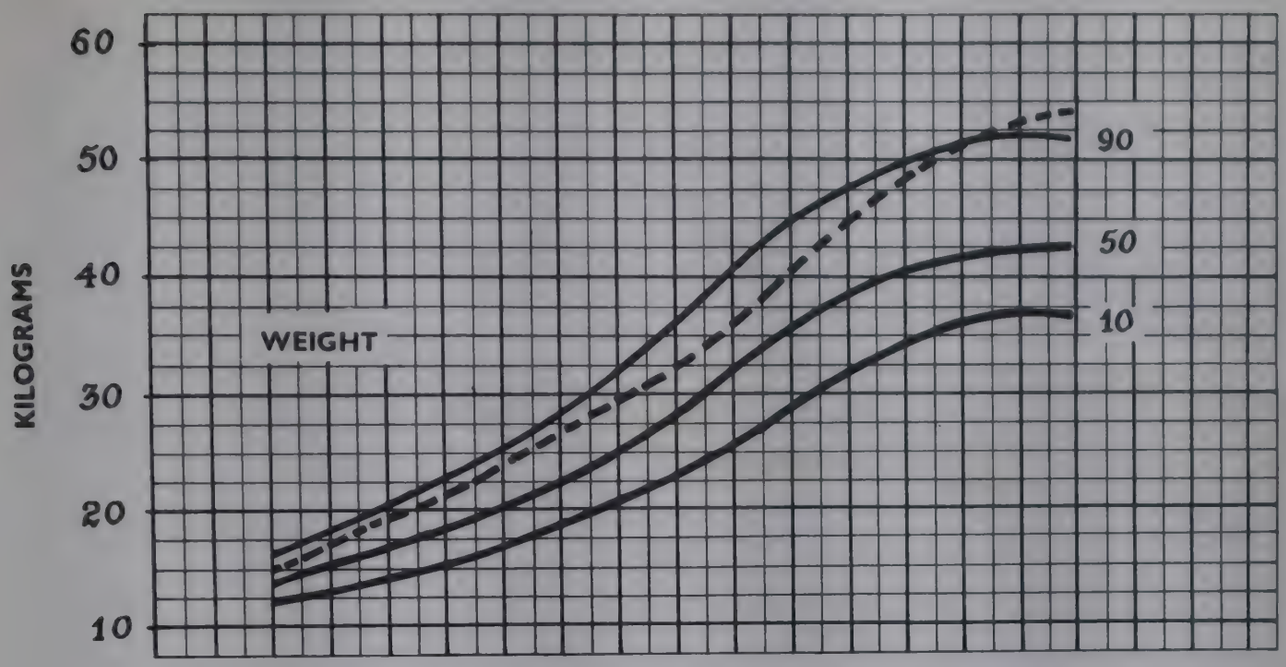
A comparison between well-to-do Indian children and American children of corresponding ages reveals that Indian boys are as tall as Americans though somewhat lighter upto the age of 14 years.

Reference : Souisa, H.M. (1969). "*Growth Studies of Children*", *M. Sc., Thesis* Osmania University.

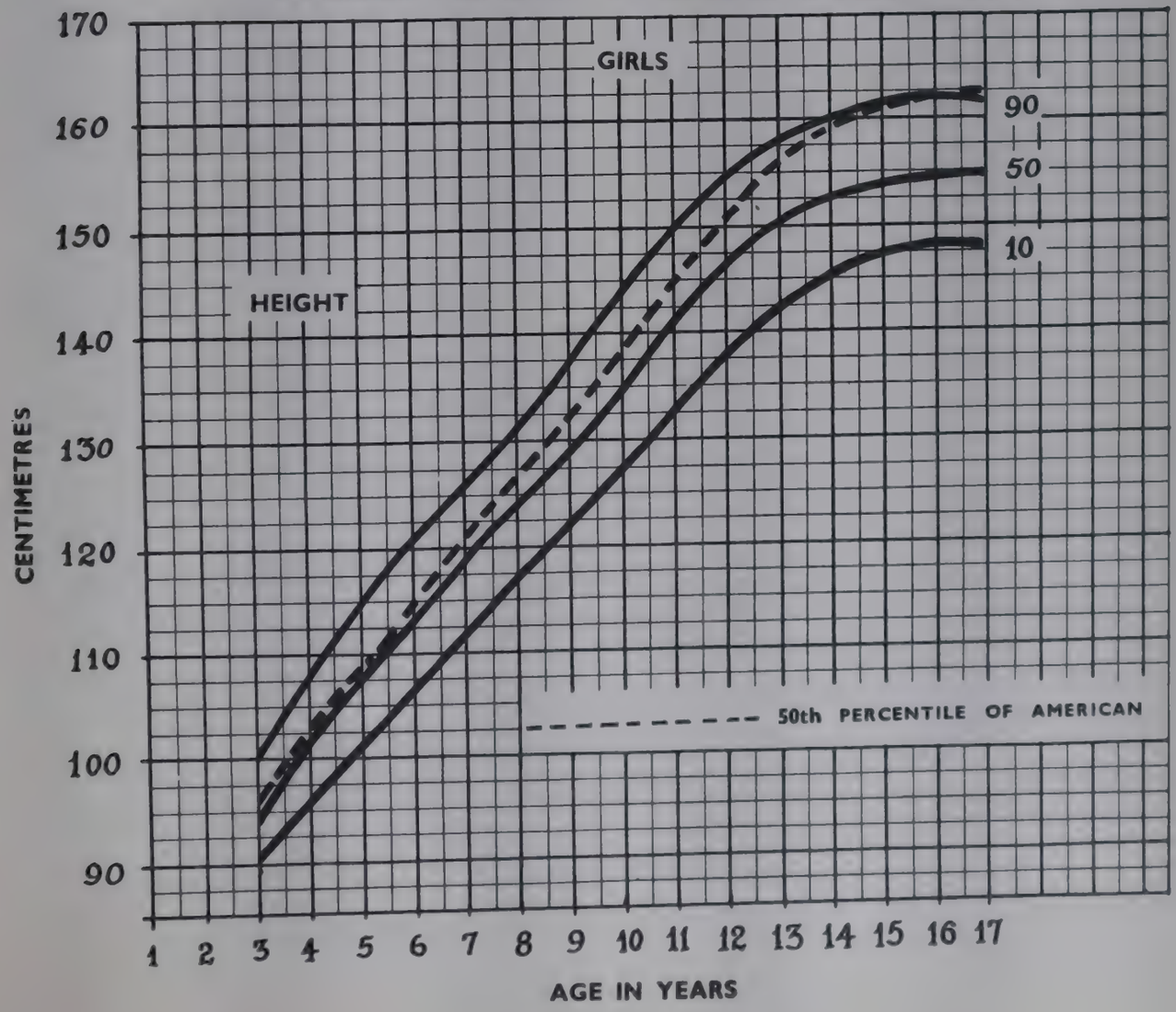

WEIGHT
KILOGRAMS
60
50
40
30
20
10
90
50
10
PERCENTILE CHARTS
OF WELL TO DO INDIAN CHILDREN
BOYS
HEIGHT
CENTIMETRES
180
170
160
150
140
130
120
110
100
90
90
50
10
50th PERCENTILE OF AMERICAN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
AGE IN YEARS

PERCENTILE CHARTS OF WELL-TO-DO INDIAN CHILDREN-GIRLS

Though well-to-do Indian boys are as tall as American boys, well-to-do Indian girls were found to be both shorter and lighter than the American subjects of corresponding ages.



PERCENTILE CHARTS OF WELL TO DO INDIAN CHILDREN



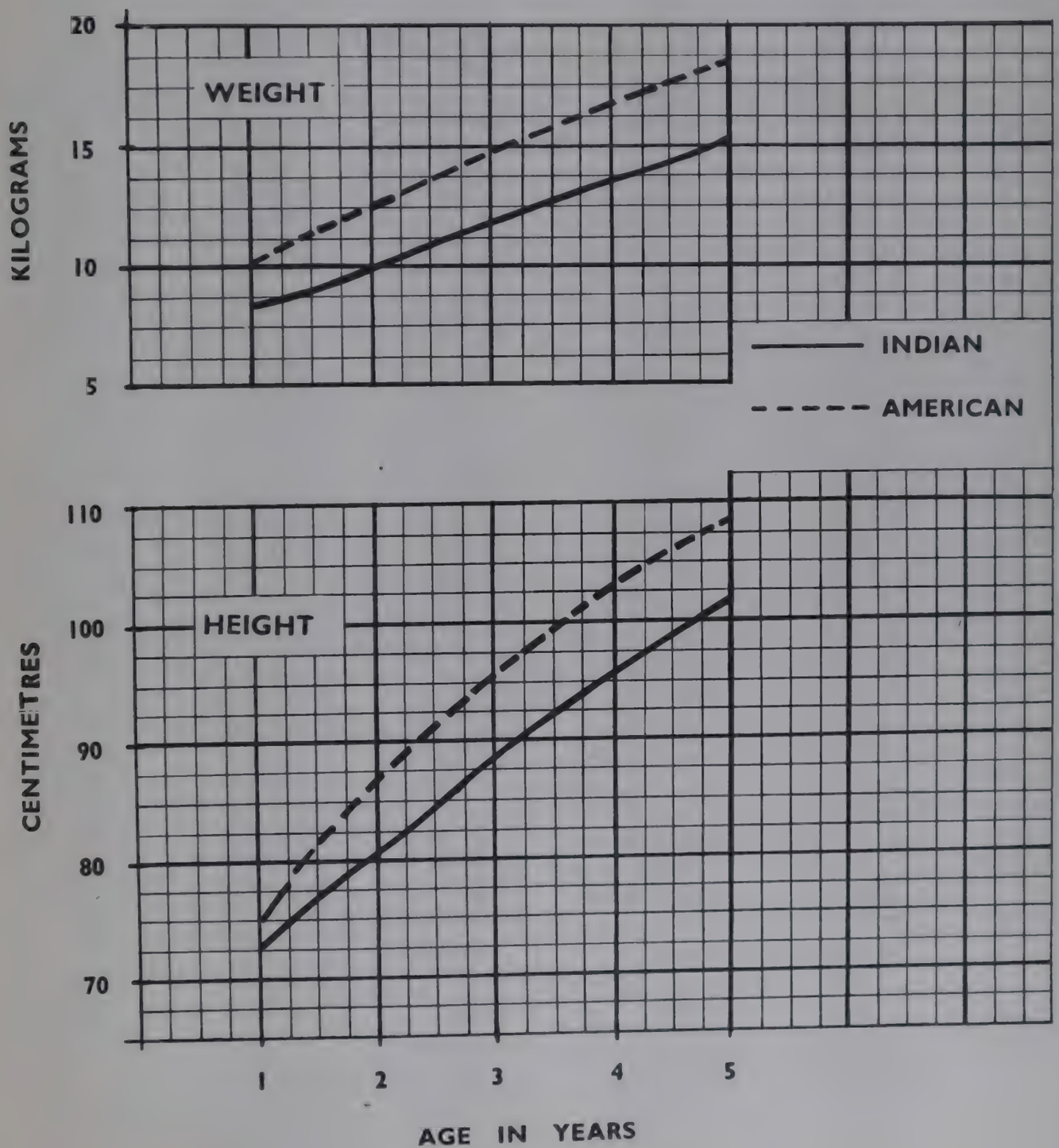
GROWTH AND DEVELOPMENT OF POOR INDIAN CHILDREN

GROWTH OF PRE-SCHOOL CHILDREN-BOYS

Indian pre-school children are both shorter and lighter than their American age-mates.

Reference: *Growth and Physical Development of Indian Children*, Part 1-A Indian Council of Medical Research.

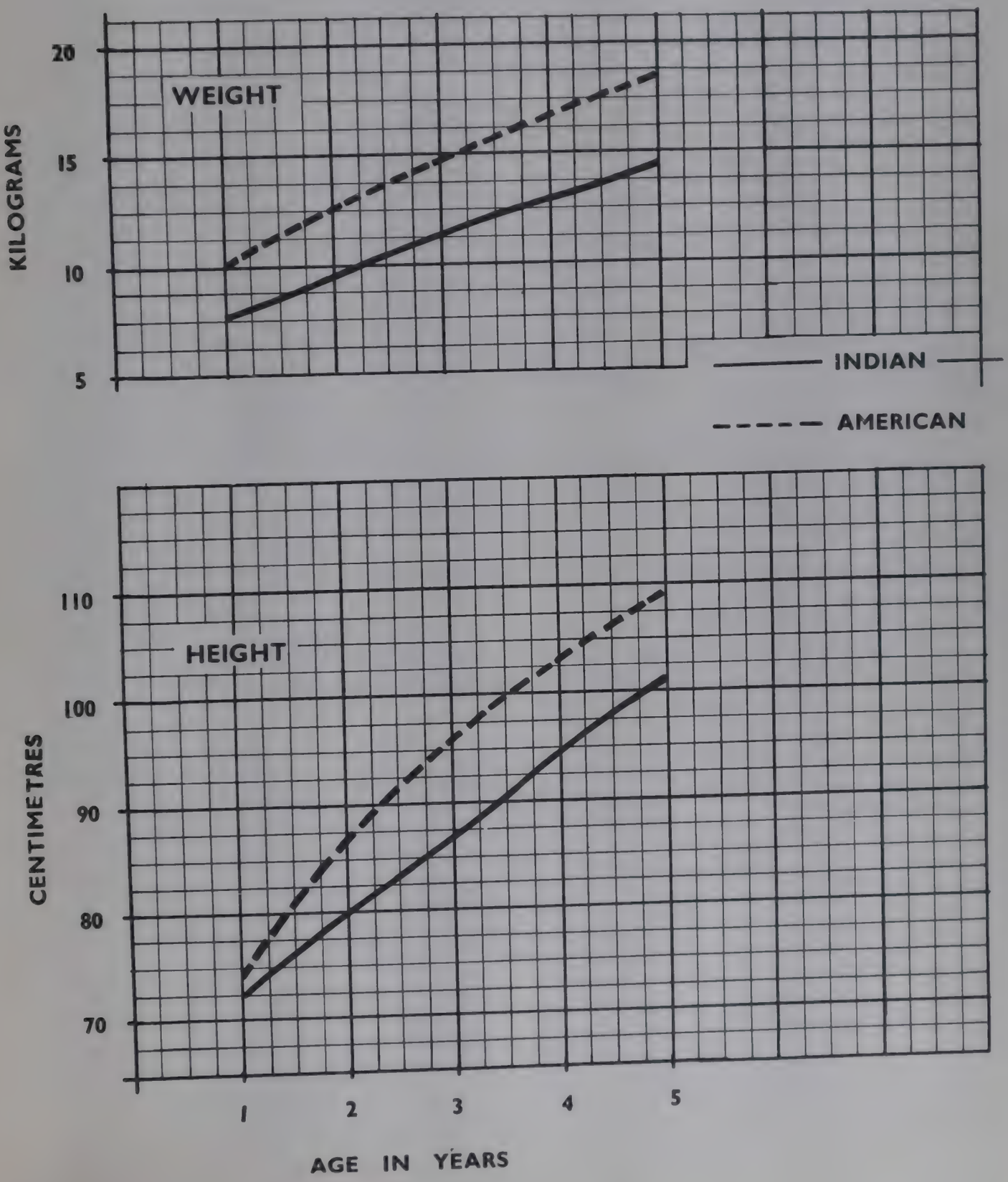
GROWTH OF PRESCHOOL CHILDREN
BOYS



GROWTH OF PRE - SCHOOL CHILDREN - GIRLS

As in the case of boys, girls of the pre-school age group are both shorter d lighter than their American counterparts.

GROWTH OF PRESCHOOL CHILDREN
GIRLS



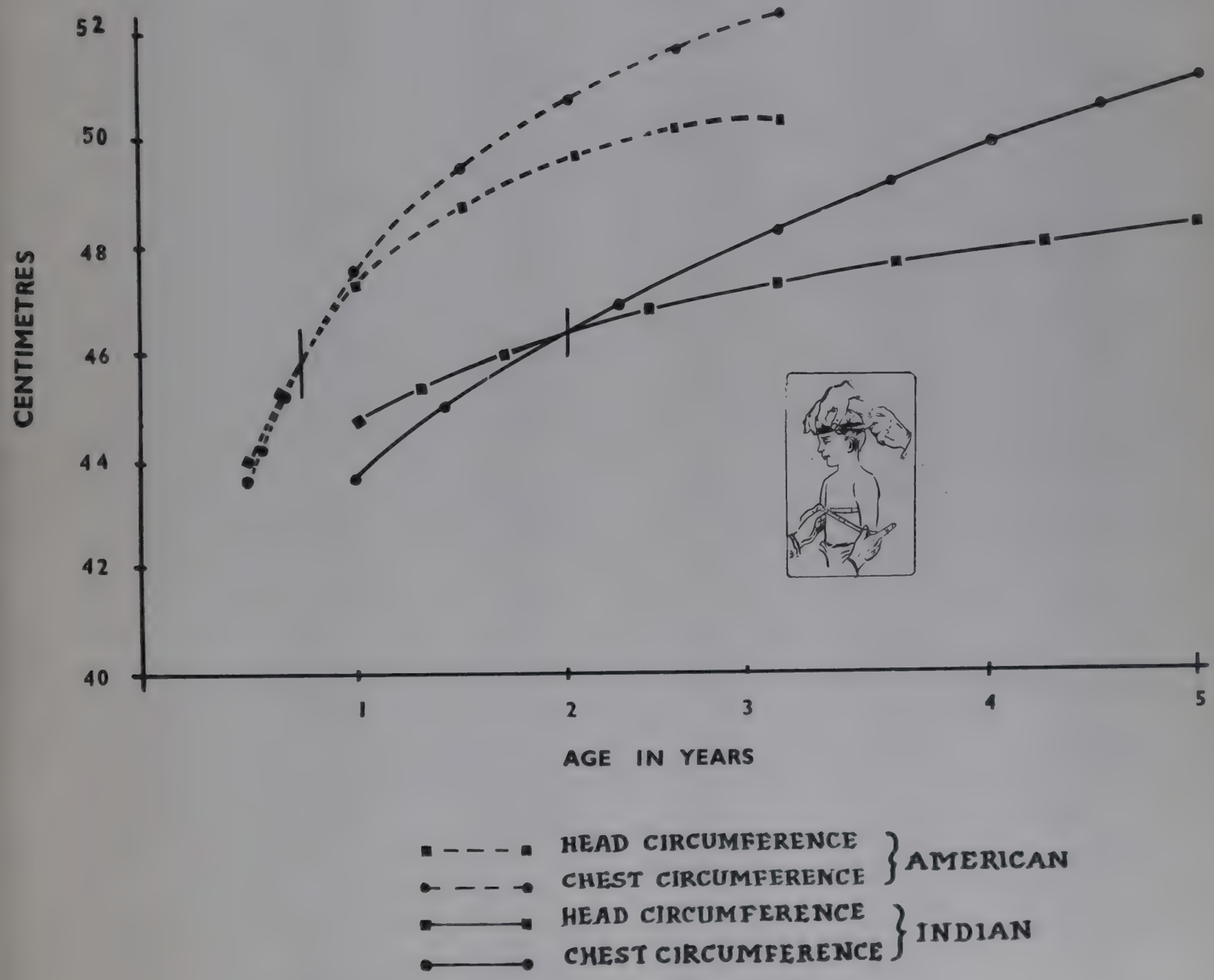
HEAD AND CHEST CIRCUMFERENCES OF INDIAN AND AMERICAN BOYS

At birth, the head circumference is larger than the chest circumference. In an American male infant, the chest circumference overtakes the head circumference by about the 9th month. In Indian boys, the crossing over of chest and head circumferences takes place around 2 years.

This indicates the growth retardation in Indian children due to wide prevalence of malnutrition.

Reference : *Growth and Physical Development of Indian Children*, Part 1-A, Indian Council of Medical Research.

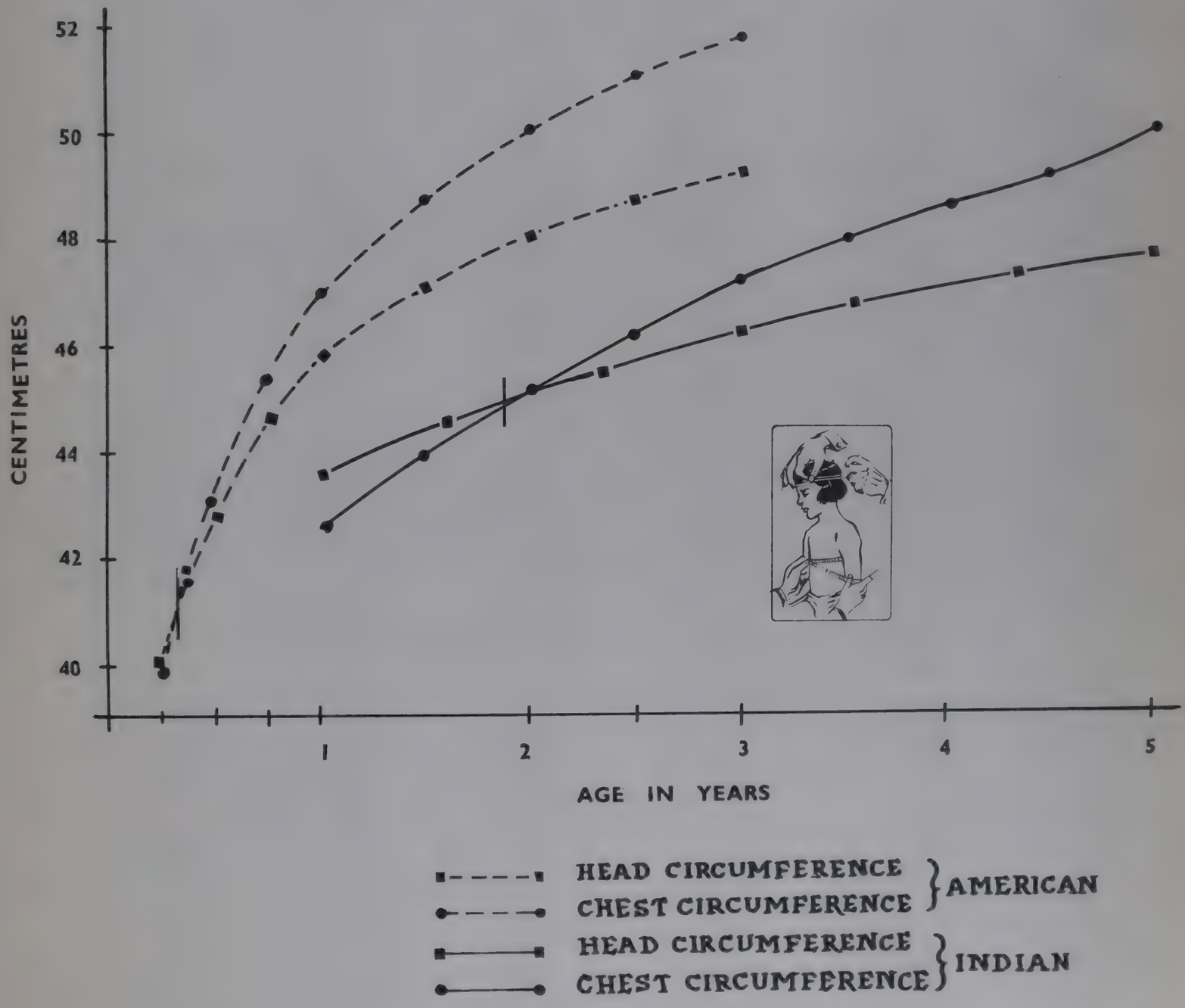
HEAD AND CHEST CIRCUMFERENCES OF INDIAN AND AMERICAN BOYS



HEAD AND CHEST CIRCUMFERENCES OF INDIAN AND AMERICAN GIRLS

While in American girls, chest circumference overtakes head circumference around 3 months, in Indian girls this occurs around 2 years.

HEAD AND CHEST CIRCUMFERENCES OF INDIAN AND AMERICAN GIRLS



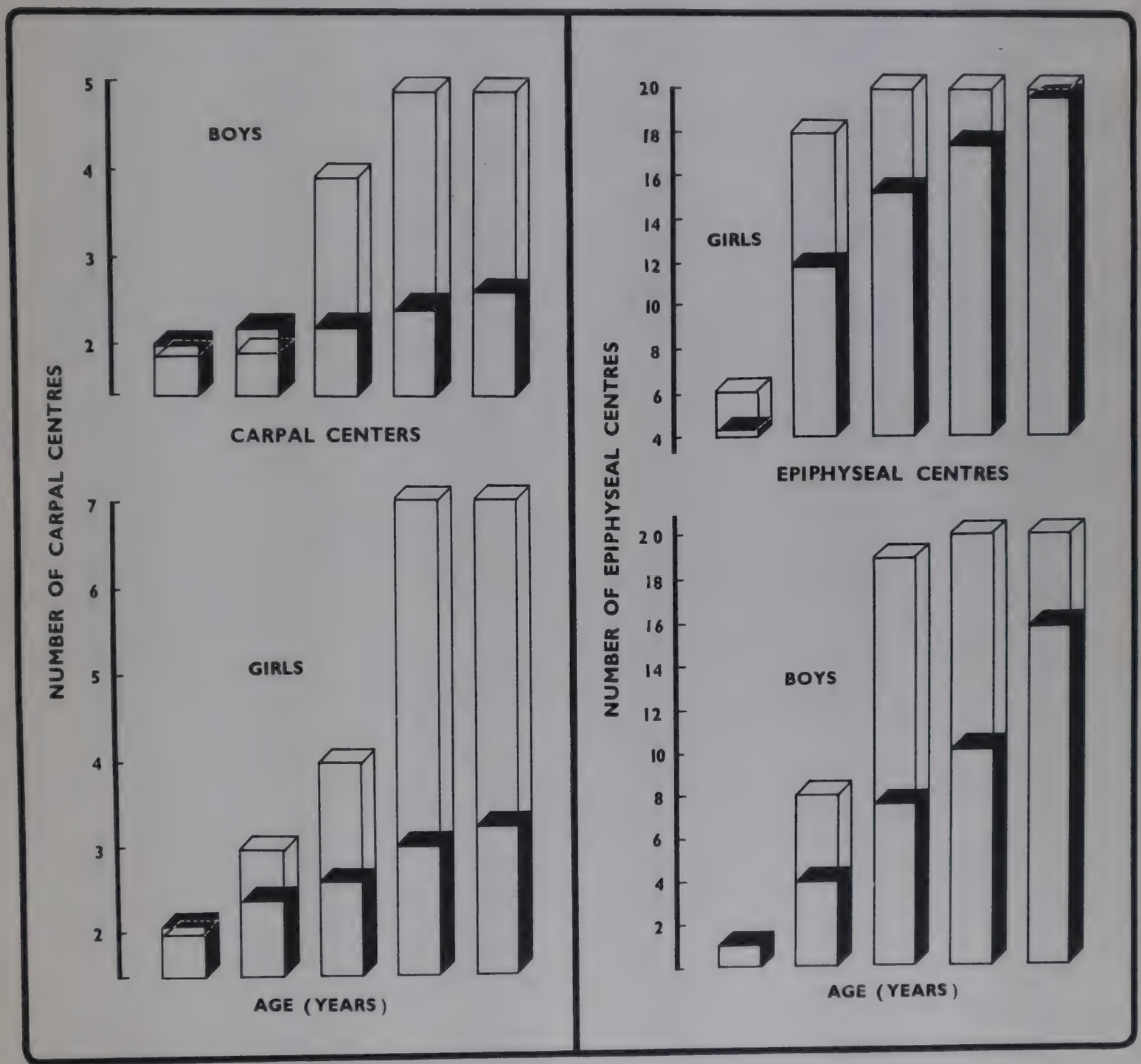
SKELETAL DEVELOPMENT OF CHILDREN-RADIOLOGICAL STUDIES OF WRIST AND HAND
A COMPARISON OF INDIAN AND AMERICAN CHILDREN

Among landmarks in physical development of the child, those pertaining to the development of the skeleton lend themselves to objective evaluation.

The ossification centres appear distinctly earlier in girls than in boys in both Indian and American subjects. The differences with regard to the appearance of carpal centres between American and Indian children are relatively small up to 2 years, but between 2 and 5 years, it would appear that Indian children are almost in a stationary phase in this regard. Similarly, the age at which various epiphyseal centres appear is considerably delayed between the 2nd and 5th years of life as compared to American children.

Reference : Annual Report, Nutrition Research Laboratories (1964–65) p. 104.

SKELETAL DEVELOPMENT OF CHILDREN
RADIOLOGICAL STUDIES OF WRIST AND HAND
A COMPARISON OF INDIAN & AMERICAN CHILDREN



PERCENTILE CHART OF INDIAN CHILDREN (1-18 YEARS) - BOYS

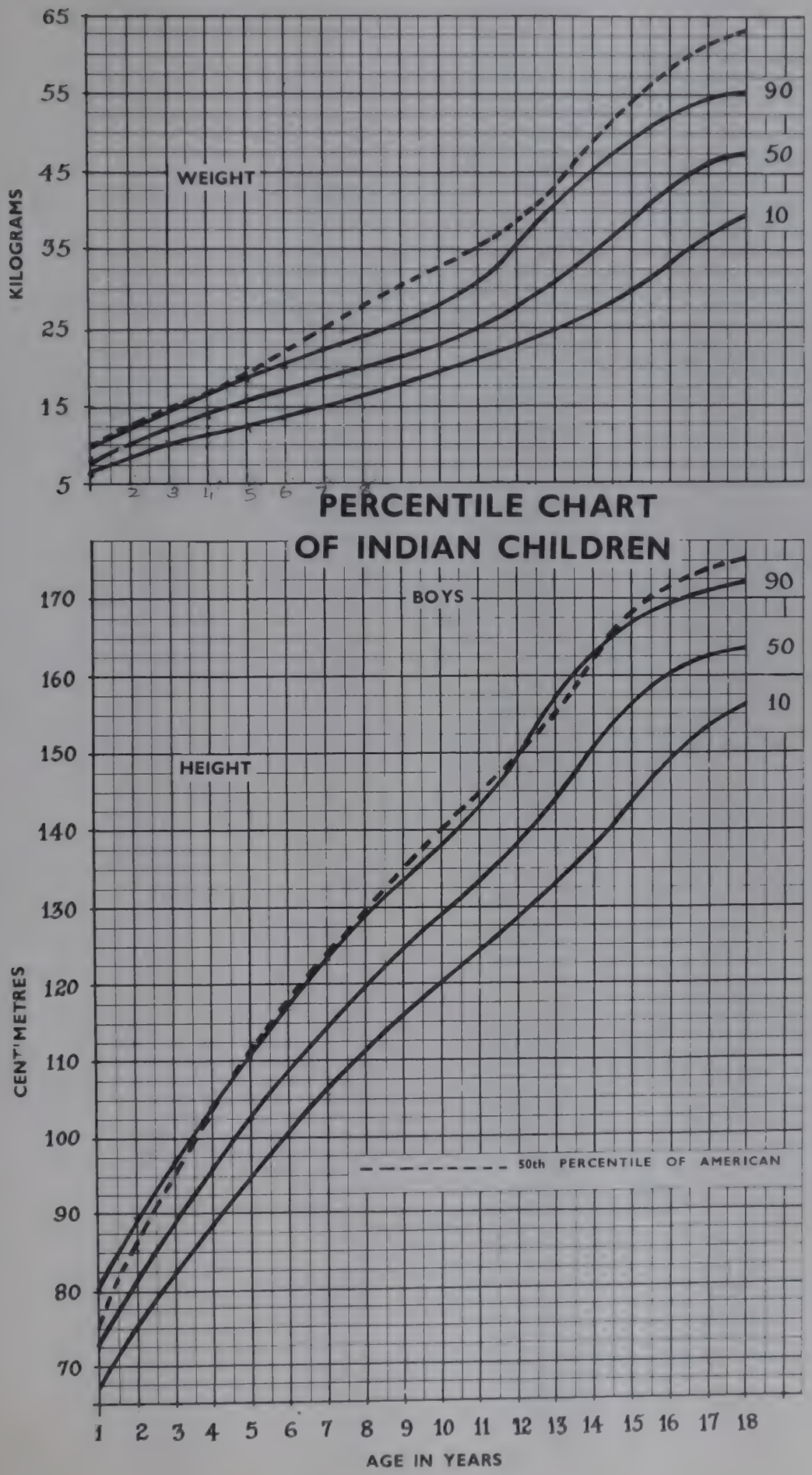
In this comprehensive growth chart for ages 1-18 years, the 10th, 50th and 90th percentile for heights and weights of Indian children are compared with the 50th percentile of American children.

The 90th percentile values for Indian children correspond with the 50th percentile values of Americans. In other words, 90 % of Indian children are shorter and lighter than their American counterparts.

'Percentile' indicates the position which a measurement would hold in a typical series of 100. Thus, 50th percentile which normally corresponds to the mean, gives the value for the 50th child of a group of 100, when they are arranged in increasing or decreasing order and where equal number of children will have measurements smaller or larger than the 50th value.

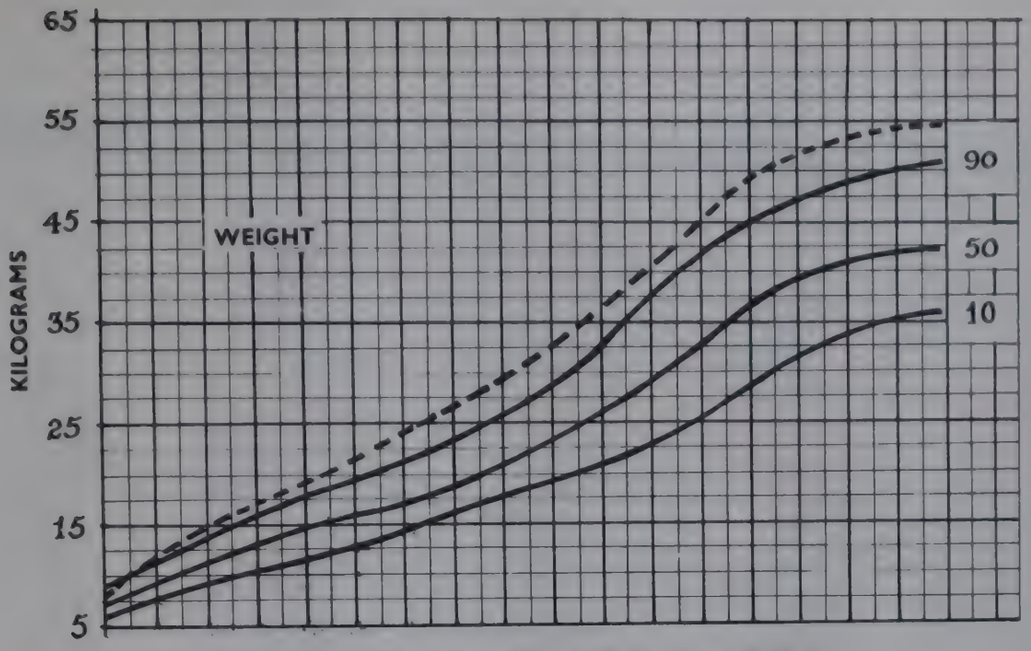
This chart is based on the results of country-wide surveys conducted under the auspices of Indian Council of Medical Research.

Reference : Growth and Physical Development of Indian Children, Part 1-A. Indian Council of Medical Research.

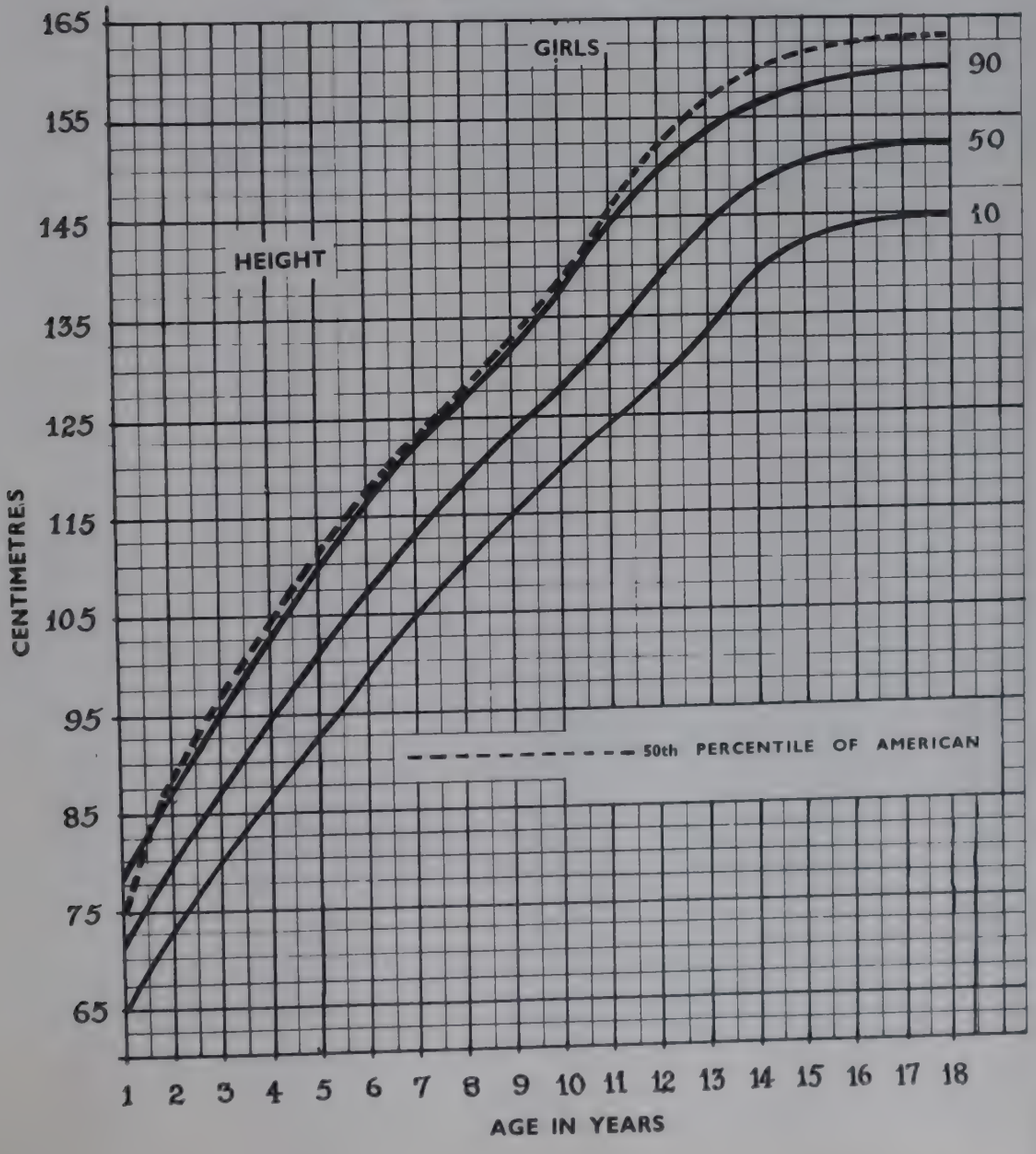

WEIGHT
KILOGRAMS
65
55
45
35
25
15
5
90
50
10
PERCENTILE CHART
OF INDIAN CHILDREN
BOYS
HEIGHT
CENTIMETRES
170
160
150
140
130
120
110
100
90
80
70
50th PERCENTILE OF AMERICAN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
AGE IN YEARS

PERCENTILE CHART OF INDIAN CHILDREN (1-18 YEARS)-GIRLS

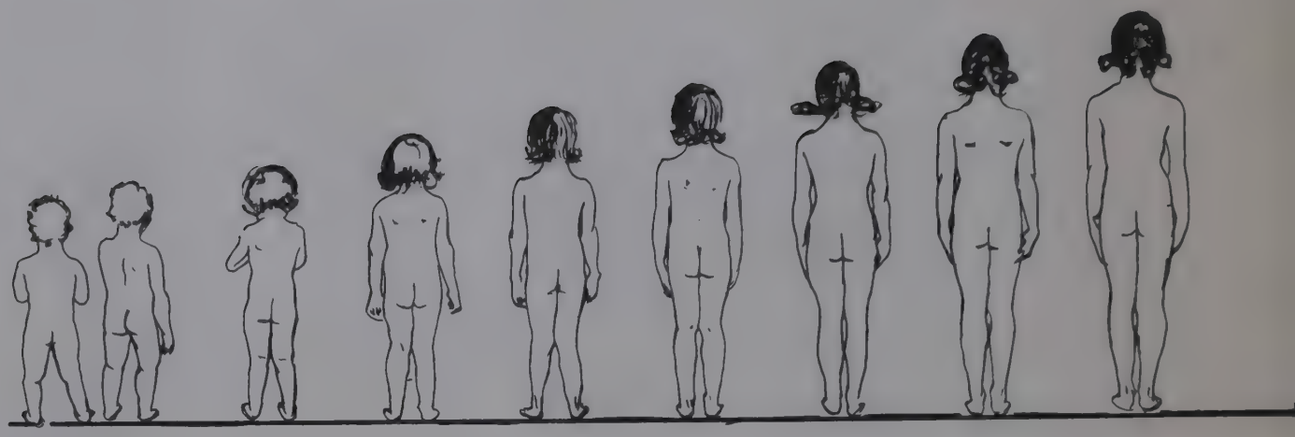
Ninetieth percentile of Indian girls between 1-18 years correspond with 50th percentile of the American for heights and weights as in the case of boys.



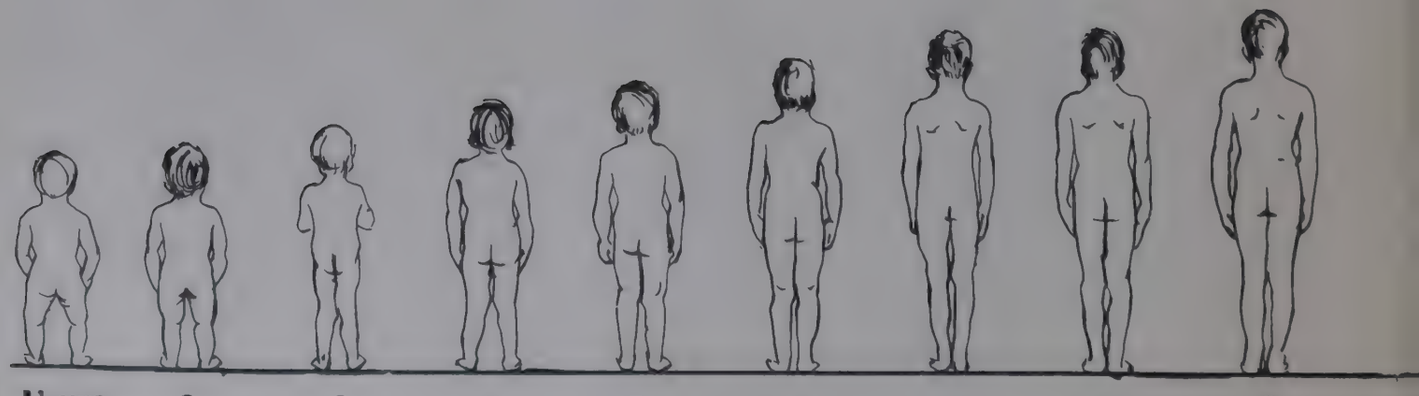
PERCENTILE CHART OF INDIAN CHILDREN



CHANGES IN BODY PROPORTIONS

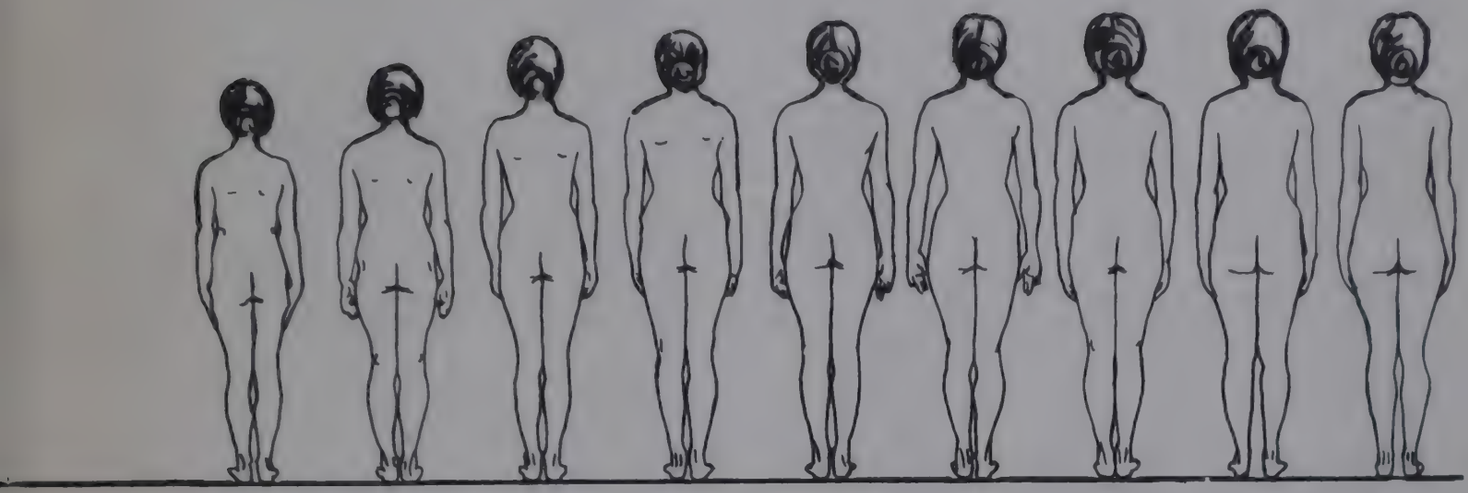


AGE	1½ yrs.	2	3	4	5	6	7	8	9
HEIGHT (cms)	71.3	80.1	87.2	94.5	101.4	107.4	112.8	118.2	122.9
WEIGHT (kgs)	7.6	9.6	11.2	12.9	14.5	16.0	17.6	19.4	21.3

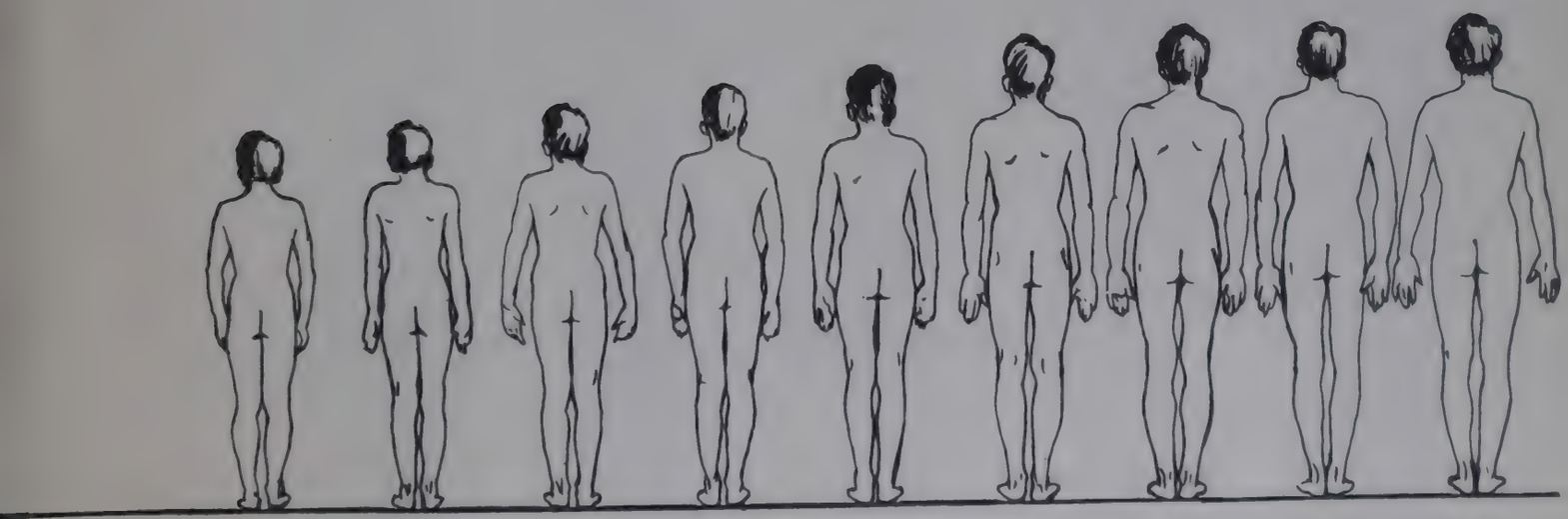


AGE	1½ yrs.	2	3	4	5	6	7	8	9
HEIGHT (cms)	72.4	81.6	88.8	96.0	102.1	108.5	113.9	119.3	123.7
WEIGHT (kgs)	8.1	10.1	11.8	13.5	14.8	16.3	18.0	19.7	21.5

CHANGES IN BODY PROPORTIONS



10	11	12	13	14	15	16	17	18
128.4	133.6	139.2	143.9	147.5	149.6	151.0	151.5	151.7
23.6	26.4	29.8	33.3	36.8	36.8	41.1	42.4	42.4



10	11	12	13	14	15	16	17	18
128.4	133.4	138.3	144.6	150.1	155.5	159.5	161.4	163.1
23.5	25.9	28.5	32.1	35.7	39.6	43.2	45.7	47.4

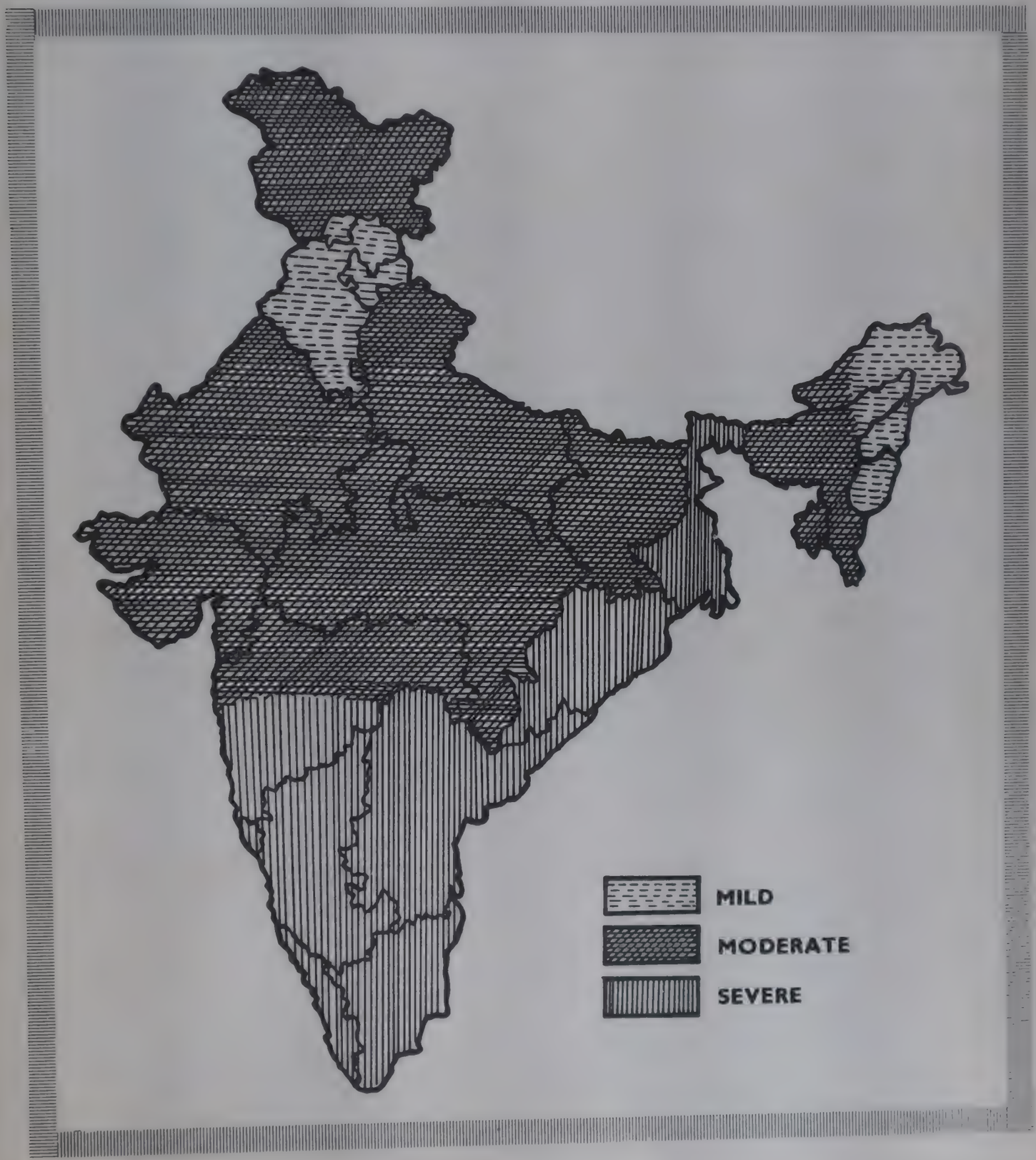
NUTRITIONAL DISORDERS IN INDIA

GEOGRAPHIC DISTRIBUTION OF PROTEIN-CALORIE MALNUTRITION IN CHILDREN

Protein - calorie malnutrition is a problem of great magnitude and is wide spread almost throughout the country, though to different degrees in different regions. Available evidence indicates that severe degrees of protein - calorie malnutrition are seen along the rice-eating belt of the country, i.e., in South India, part of Maharashtra, Orissa and West Bengal.

Protein - calorie malnutrition of mild and moderate severity is reported from other parts of India also.

GEOGRAPHIC DISTRIBUTION OF PROTEIN CALORIE MALNUTRITION IN CHILDREN



PROTEIN-CALORIE MALNUTRITION

Protein-calorie malnutrition is widely prevalent among the poor segments of our population throughout the country. This form of malnutrition is more prevalent in the southern and eastern parts of the country, than in the other regions.

Kwashiorkor is characterised by failure to grow, irritability and mental apathy, oedema, muscular wasting and damaged liver. Since there is a great need for both protein and energy to meet the demands for rapid growth, dietary restriction of either protein or calories or both, as is most often the case, will result in the development of kwashiorkor. Infections and infestations have a precipitating role. Studies recently conducted in India and elsewhere have indicated that children who have once suffered from severe protein-calorie malnutrition in their early childhood may suffer from permanent physical stunting.

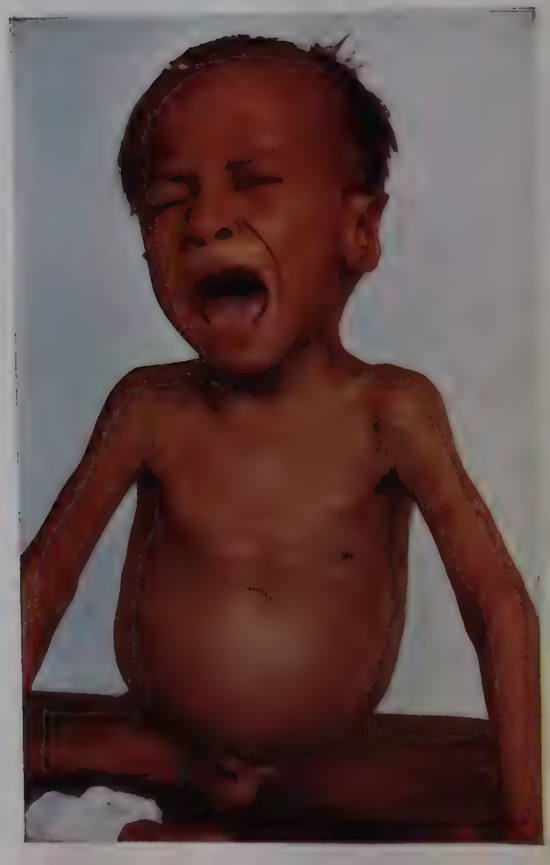
Inadequacy of food supplies, poverty of the masses, their ignorance and food prejudices make the problem of prevention one of real difficulty. Proper use of available resources is an important step in combating this deficiency. Successful treatment of kwashiorkor with diets based upon vegetable proteins especially legumes, indicate that educating the mothers in appropriate infant and child feeding practises making use of these locally available cheap vegetable foods will go a long way in controlling this problem.

PROTEIN – CALORIE MALNUTRITION

A child suffering from Kwashiorkor - an advanced state of Protein-Calorie Malnutrition. Note the oedema of lower extremities and skin changes on the right leg.

Changes in the hair are frequently seen in children suffering from Protein - Calorie Malnutrition. Note the Coppery - red discolouration of hair.

Cases of Kwashiorkor and Marasmus are frequently encountered in the same community. The child in the centre has kwashiorkor and shows marked changes in the skin. The other two children are marasmic.



A child suffering from Marasmus. Note almost complete absence of subcutaneous tissues and marked wasting of muscles.

MARASMUS

Marasmus - a deficiency mainly of calories, leading to growth retardation and emaciation occurs in early infancy and is principally a condition resulting from gross undernutrition. This is mainly due to faulty feeding habits particularly when there is a failure of lactation. This could be prevented by adopting proper infant feeding practices and utilising the available cheap food resources.

PERCENTAGE PREVALENCE OF NUTRITIONAL DEFICIENCY SIGNS IN PRE-SCHOOL CHILDREN

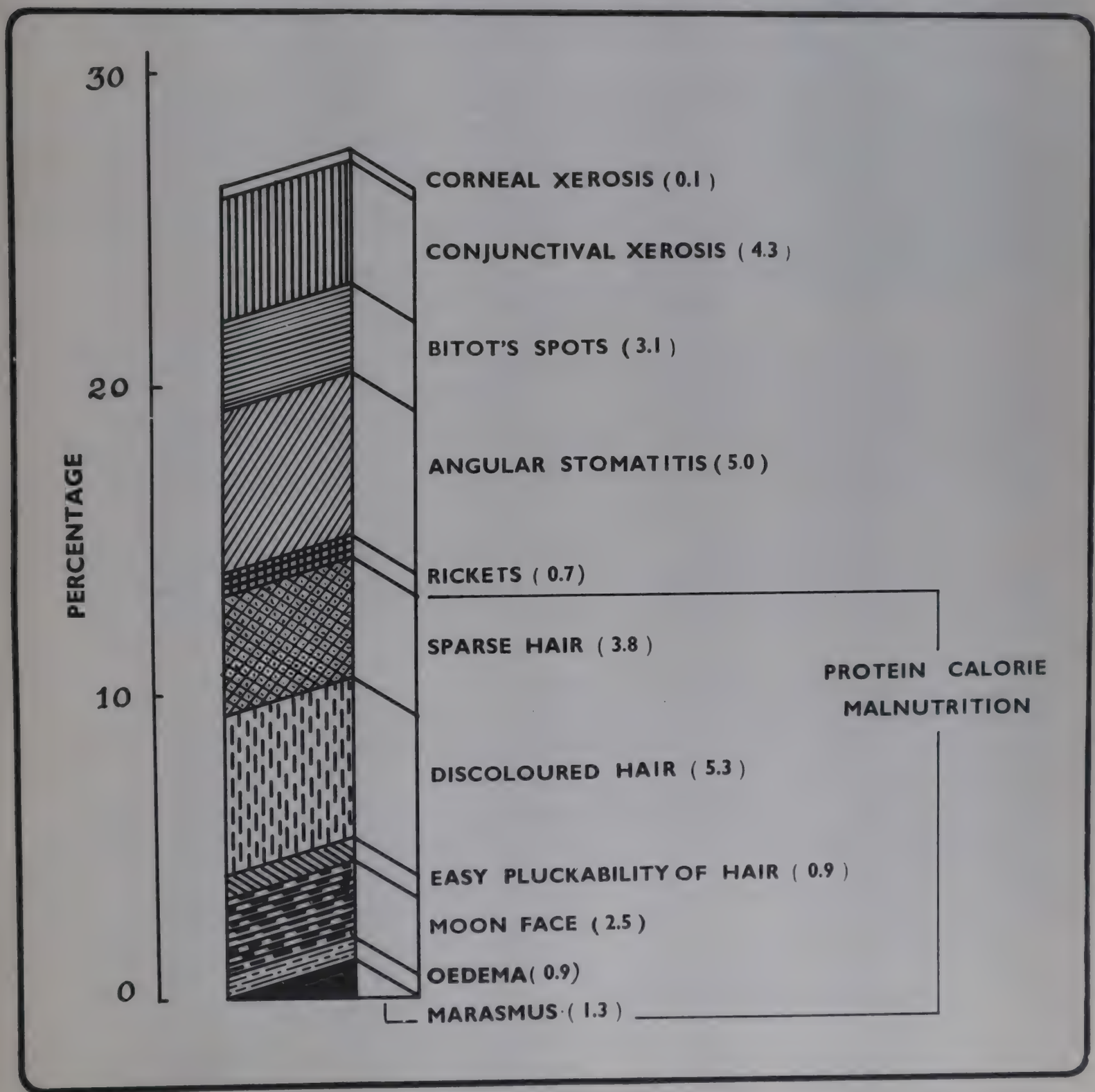
Pre-school children, form an important vulnerable segment of the population and their nutritional status generally reflects the nutritional status of tne community.

Surveys conducted in different parts of India indicate that protein - calorie malnutrition is the major nutritional problem in this group.

Ocular manifestations of vitamin A deficiency like conjunctival and corneal xerosis and Bitot's spots and oro-lingual manifestations of vitamin B-Complex deficiency like angular stomatitis are other deficiency signs frequently seen among toddlers.

Reference : Based on the surveys conducted in India (Six Centres) under the auspices of Indian Council of Medical Research.

NUTRITIONAL DEFICIENCY SIGNS IN PRESCHOOL CHILDREN PERCENTAGE PREVALENCE



B-COMPLEX DEFICIENCY

Among the nutritional deficiency signs, those of B-Complex deficiency are widely prevalent, especially in expectant women and children. Characteristic among them are the reddish ulcerative lesions at the angles of the mouth, raw and red tongue and sometimes rough corny papules in the naso-labial region.

Propagation of the use of green leafy vegetables and milk will go a long way in the prevention of these signs.

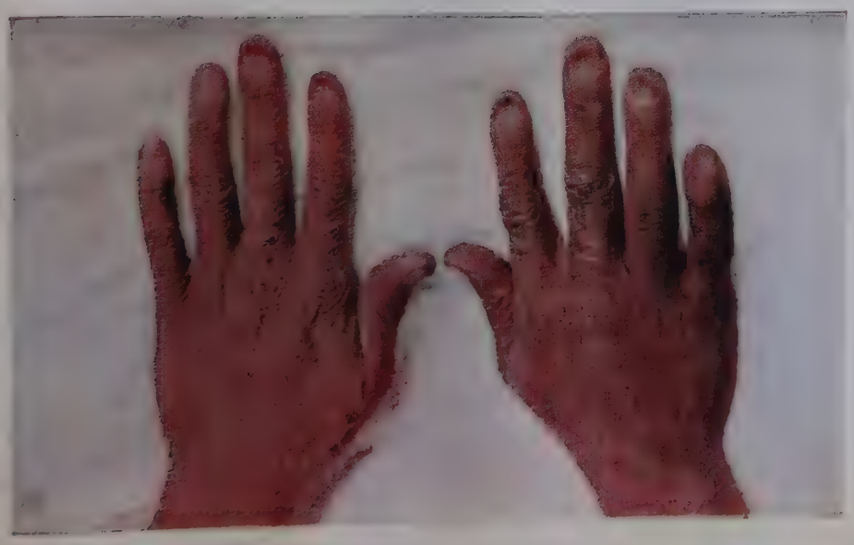
NUTRITIONAL ANAEMIA

Nutritional anæmia is one of the major health problems of India and is particularly seen among pregnant women and pre-school children as their requirements for essential nutrients are relatively high. The seriousness of the problem is evident when it is realised that approximately 10 % of all maternal deaths are directly due to anæmia. Low birth weights among Indian infants are also attributed to anæmia.

Nutritional anæmias are due to deficiency of iron, folic acid and vitamin B_{12}. About 10 - 30 % of the population suffer from iron deficiency which is characterised by paleness of the oro-lingual mucosa and conjunctiva and spoon shaped nails of fingers and toes.

Urgent steps are needed to prevent and control anæmias, particularly among pregnant women. The importance of a long-term education programme to encourage the production and consumption of protective foods rich in these nutrients can not be over emphasized. As an immediate step, the most obvious and feasible approach to the prevention and control of anæmia in pregnant women would be through the distribution of daily supplements of 60 mg of elemental iron and 500 mcg of folic acid.

Among vitamin deficiency signs Angular Stomatitis, due to deficiency of riboflavin is one of the most common. Note the cracks at the angles of the mouth and the changes in the tongue.



Koilonychia - spoon shaped nails, is frequently seen in subjects suffering from iron deficiency Anæmia.

Phrynoderma - a manifestation of deficiency of essential fatty acids. Note the characteristic horny, cone shaped papules.

A child suffering from Rickets. Note the large square head, beading of ribs, widened wrist joints and bow - legs. The child is also marasmic.

PHRYNODERMA
(Toad Skin)

This is a condition seen mostly in children of school going age. It occurs as raised horny papules generally distributed on the outer (lateral) and back (posterior) parts of both the lower and upper extremities. Most often, they tend to aggregate around the knee and elbow joints. For a long time, phrynoderma was considered as beir g due to deficiency of vitamin A. Recent researches in Nutrition Research Laboratories, however have led to the conclusion that this is the result of a deficiency of essential fatty acids. Vegetable oils like safflower oil and sesame oil are rich sources of essential fatty acids.

An addition of about 15 g of vegetable oils to the daily diet will prevent the occurrence of phrynoderma.

RICKETS

Rickets is a disease due to deficiency of vitamin D and occurs in young children. The disease is characterised by deformities of the bones like knock-knees and bow-legs which may last throughout life. Rickets is particularly apt to occur in infants living in ill-ventilated houses and whose diets are deficient in vitamin D and calcium.

Vitamin D is present in eggs, milk and fish-liver oil. It is also formed in the skin by the action of sunlight which is thus the cheapest source of this vitamin.

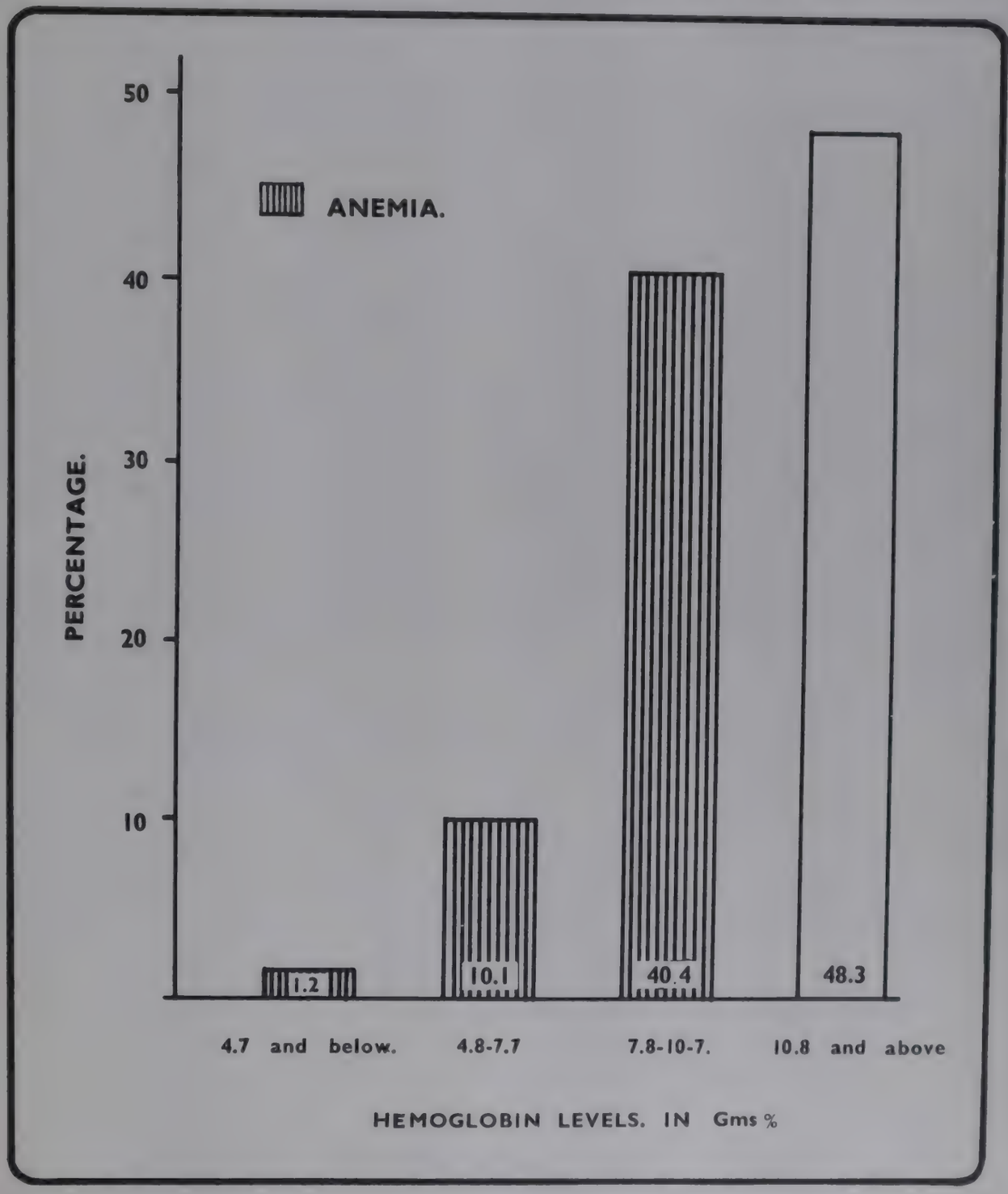
Adequate exposure to sunlight and administration of fish-liver oil would protect infants from this disease.

PERCENTAGE DISTRIBUTION OF HAEMOGLOBIN LEVELS IN PRE-SCHOOL CHILDREN

One of the major nutritional and public health problems among pre-school children is nutritional anæmia. Hæmoglobin surveys carried out in the country show that 52 % of the toddlers among the poor socio-economic groups have hæmoglobin levels below 10. 8 g %.

This diagram is based on the results of hæmoglobin surveys carried out under the auspices of the Indian Council of Medical Research in six different regions of the country.

PERCENTAGE DISTRIBUTION OF HAEMOGLOBIN LEVELS IN PRESCHOOL CHILDREN



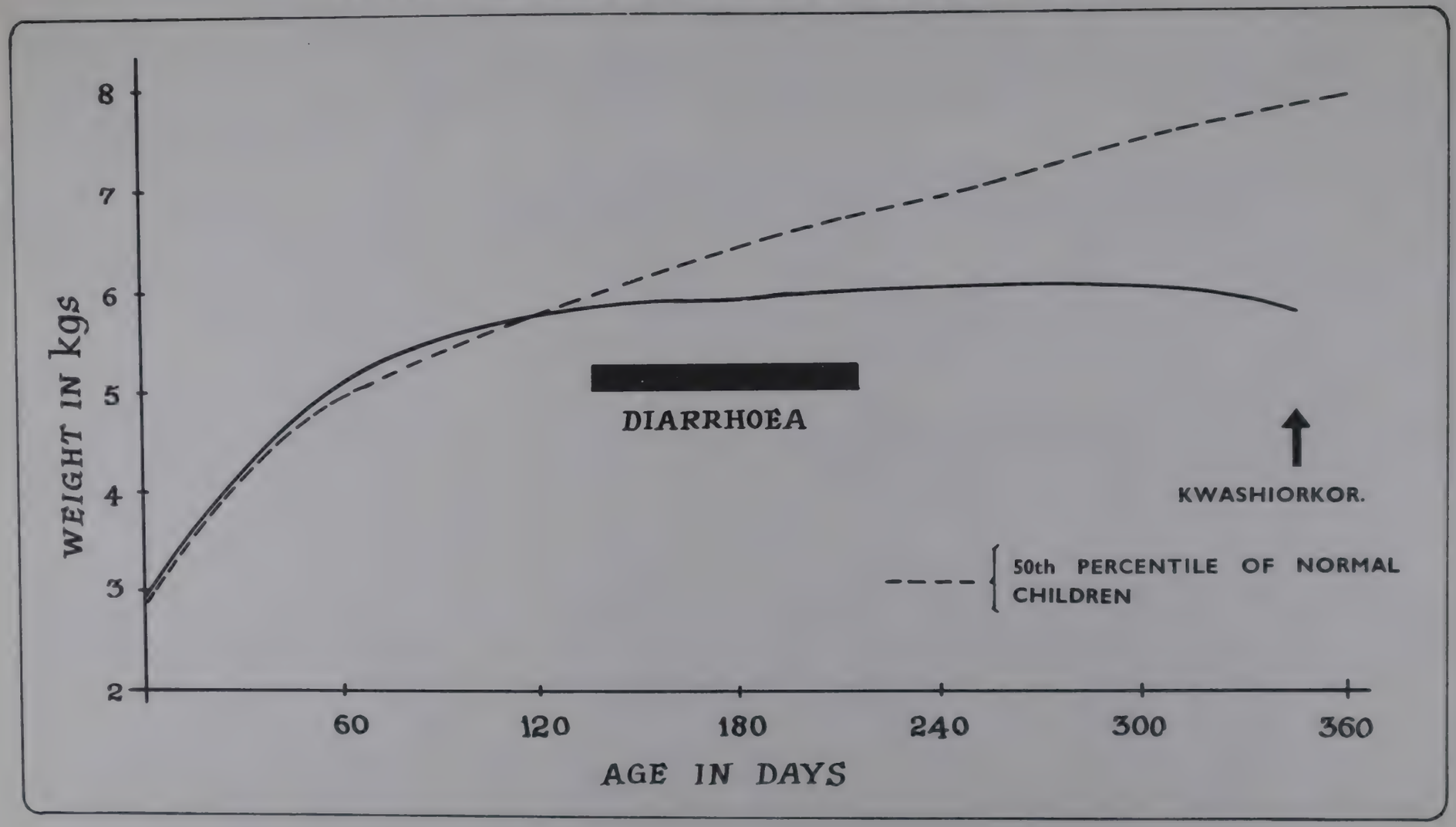
WEIGHT CHART OF AN INFANT WHO DEVELOPED KWASHIORKOR

The growth rate and nutritional status of infants in poor community are relatively satisfactory during the first 6 months. However, after that age, due to faulty feeding habits, frequent infections like diarrhoeas, etc., early signs of malnutrition set in, though full-fledged nutritional deficiency diseases like kwashiorkor and marasmus are generally seen beyond the first year.

The onset of malnutrition in late infancy is revealed by the flattening of the growth curves in this period and the occurrence of mild signs of nutritional deficiency, which if not taken care of, will lead to florid kwashiorkor-a severe type of protein malnutrition.

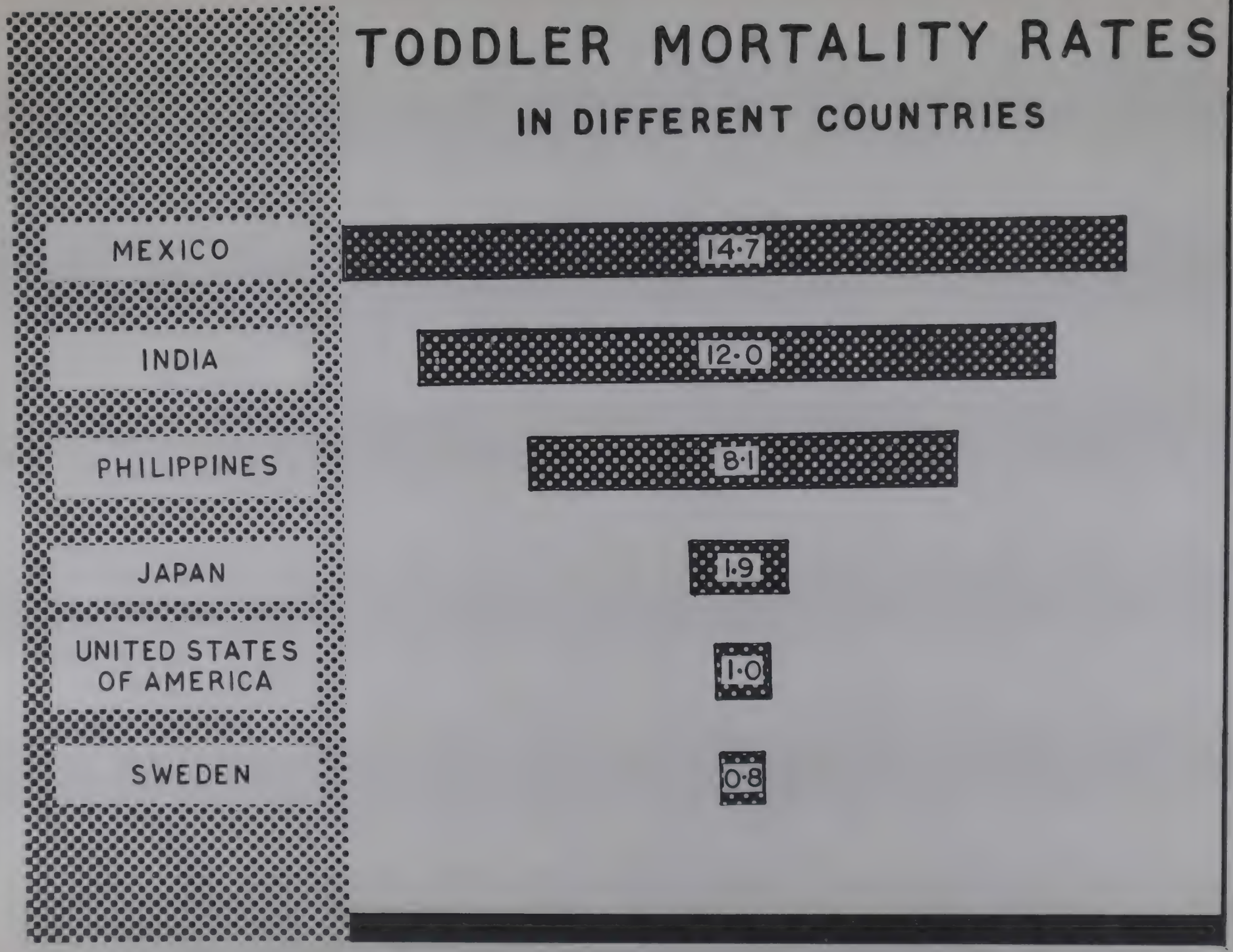
Source : Swaminathan, M. C. Jyothi, K. K., Raghbir Singh, Shanta . Madhavan and Gopalan, C. (1964). *Ind. Paed.* **1**: 255.

WEIGHT CHART OF AN INFANT WHO DEVELOPED KWASHIORKOR



TODDLER MORTALITY RATES IN DIFFERENT COUNTRIES

Like infant mortality rate, toddler (pre-school child) mortality rate is also high in most developing countries. Infant and toddler deaths together account for a high proportion of total mortality in India. Thus, while children in the age group 1 - 5 years constitute about 16.5 % of the total population, deaths within this age group account for 40 % of the total deaths in the country. Although there has been a steady decline in infant mortality rate in our country during the last decade, the toddler mortality rate has remained almost stationary. Malnutrition is a major factor underlying this high toddler mortalty rate.


TODDLER MORTALITY RATES
IN DIFFERENT COUNTRIES
MEXICO
14·7
INDIA
12·0
PHILIPPINES
8·1
JAPAN
1·9
UNITED STATES OF AMERICA
1·0
SWEDEN
0·8

PREVALENCE OF PROTEIN-CALORIE MALNUTRITION BY BIRTH ORDER

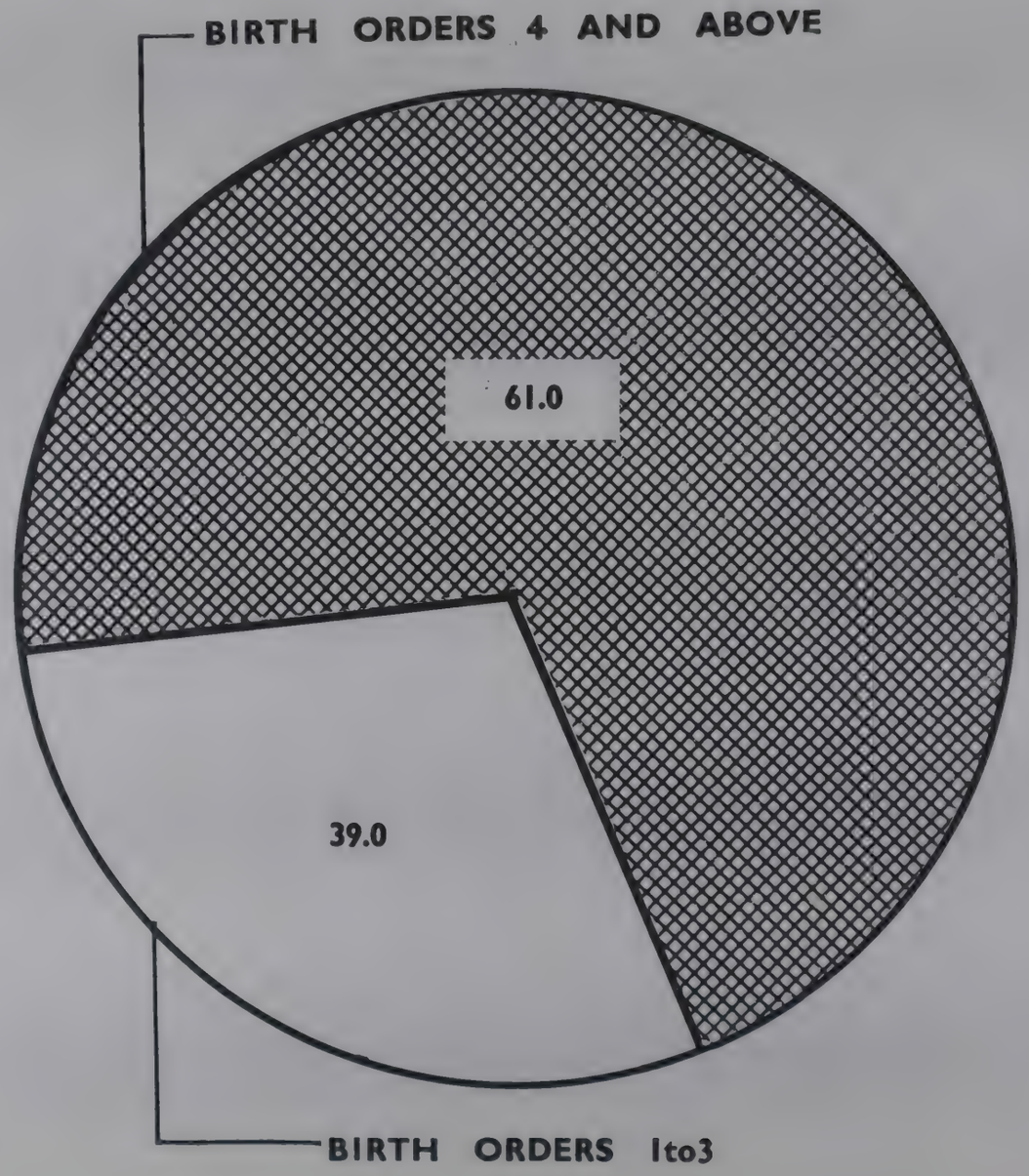
Children below 5 years who from the nutritional stand point, are the most vulnerable segment, constitute over 15 % of the population in India. The pre-school child mortality rate has, more or less, remained stationary, amounting to 40 % of the total deaths in the country. The enoromous wastage of children is apparently a motivation to have large families, especially among the poor segments of the population.

An analysis of several hundred cases of severe protein - calorie malnutrition admitted to the hospitals showed that only 39 % of these children belonged to birth orders 1 to 3 as against 61 % belonging to birth orders 4 and above.

Among the programmes likely to make a profound impact on the health and nutritional status of pre-school children in India, in the long run, limitation to smaller families is extremely important.

Source: Gopalan. C. (1968). *J. Trop. Paediatrics*, **14**: 228.

PERCENTAGE PREVALENCE OF PROTEIN CALORIE MALNUTRITION BY BIRTH ORDER

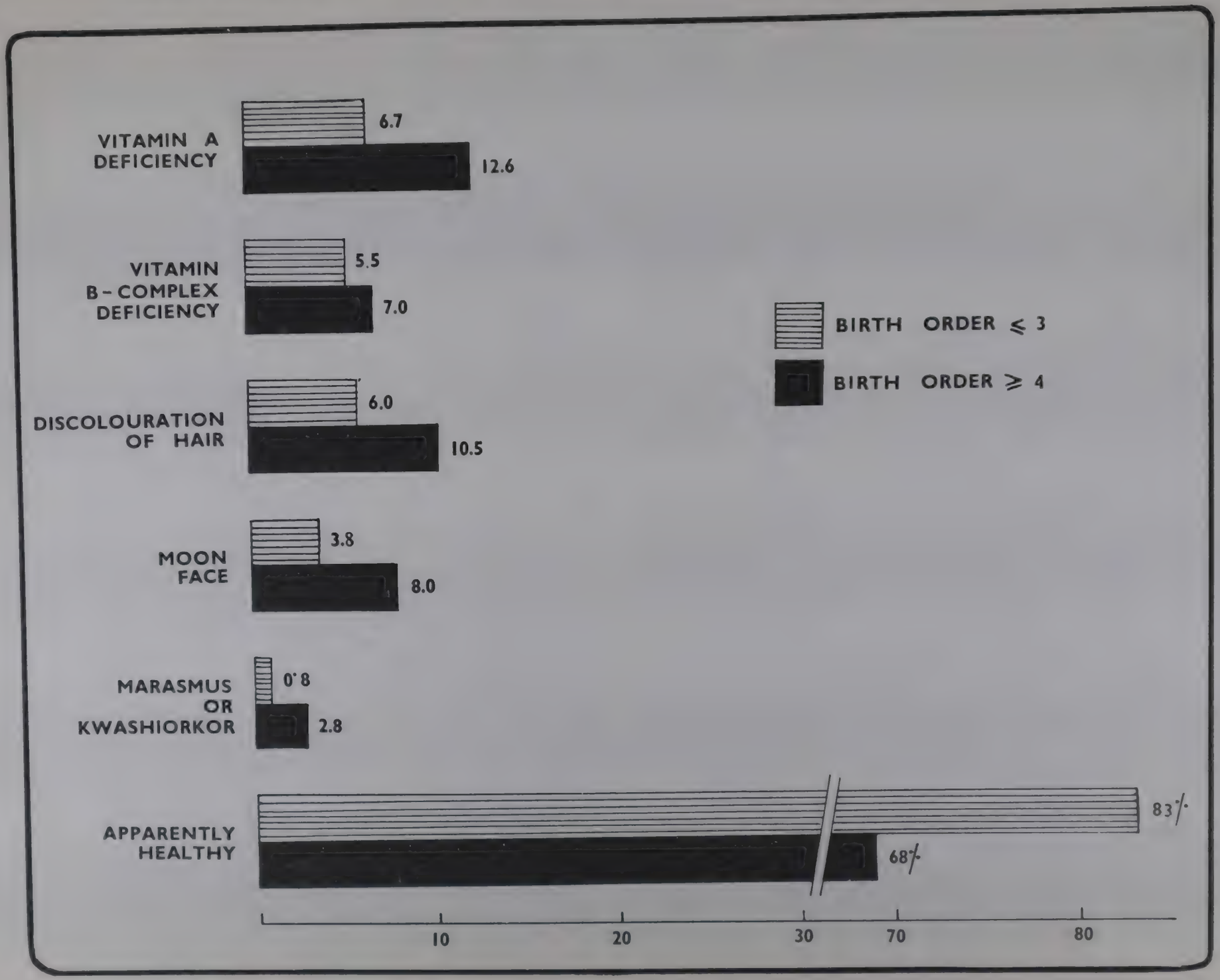


BIRTH ORDER AND PERCENTAGE PREVALENCE OF DEFICIENCY SIGNS IN PRE-SCHOOL CHILDREN

In a field study covering 1400 pre-school children, it was found that 32% of children belonging to birth orders 4 and above exhibited various signs of malnutrition, while only 17 % of children of earlier birth orders showed such evidences. From these studies it is obvious that smaller the family size, better is the nutritional status of the children .

Source: Gopalan, C. (1968). *J. Trop. Paediatrics*, **14**: 228.

BIRTH ORDER AND PERCENTAGE PREVALENCE OF DEFICIENCY SIGNS IN PRESCHOOL CHILDREN

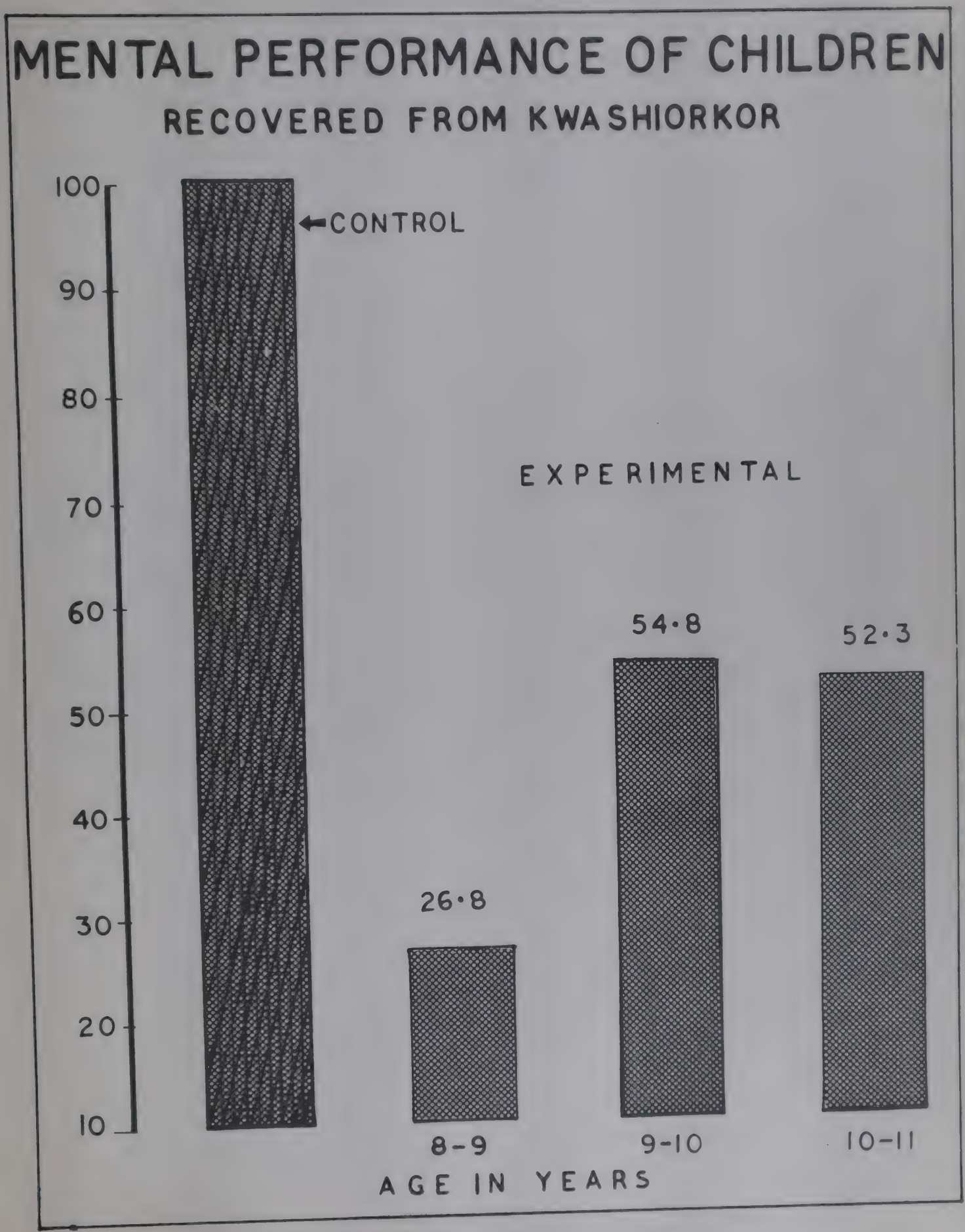


MENTAL PERFORMANCE OF CHILDREN RECOVERED FROM KWASHIORKOR

Increasingly greater attention is now being paid to the long-term effects of malnutrition in children. There is some evidence that an episode of severe undernutrition in early childhood not only affects physical growth but may also influence mental development.

Studies conducted at the Nutrition Research Laboratories showed that the mental performance of children who had earlier suffered from severe malnutrition was inferior to that of other children in the same community. However, whether this difference is solely attributable to the episode of malnutrition or due to attendant factors requires to be investigated.

Source : Champakam, S., Srikantia, S. G. and Gopalan, C. (1968). *Amer. J. Clin. Nutr.* **21**: 844.

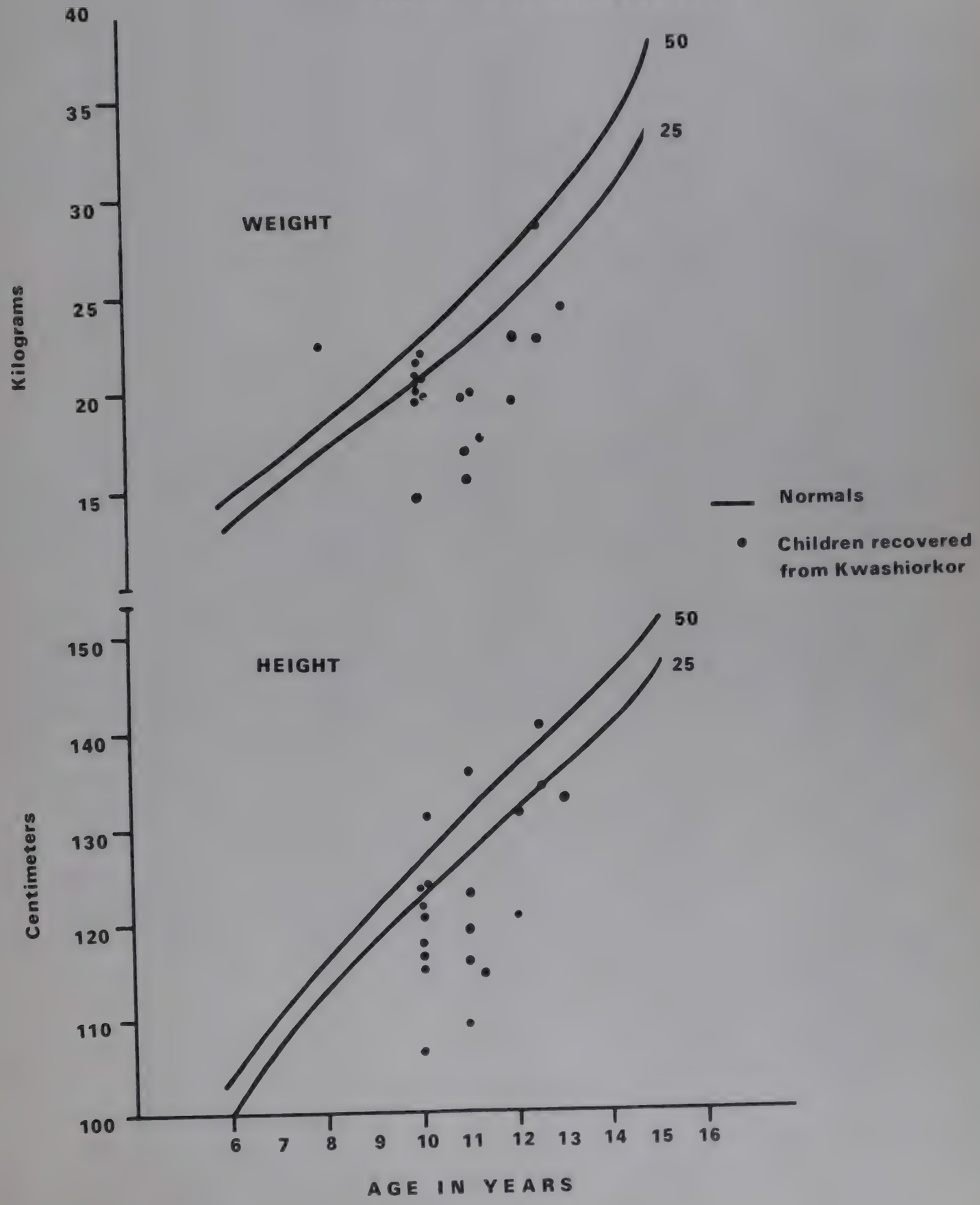

MENTAL PERFORMANCE OF CHILDREN
RECOVERED FROM KWASHIORKOR
100
90
80
70
60
50
40
30
20
10
CONTROL
EXPERIMENTAL
26·8
54·8
52·3
8-9
9-10
10-11
AGE IN YEARS

GROWTH OF CHILDREN RECOVERED FROM KWASHIORKOR

One of the cardinal features of kwashiorkor - an advanced state of protein-calorie malnutrition, is growth retardation. The long-term effects of severe protein-calorie malnutrition on growth and physical development require serious attention.

Longitudinal studies conducted on children who had earlier been successfully treated for kwashiorkor indicate that the heights and weights of these children generally fell well below the community norms. The scatter diagram here shows that these children are either equal to or below the 25th percentile of the community, suggesting thereby that an episode of severe protein-calorie malnutrition during early life might have contributed to this poor growth performance in later years.

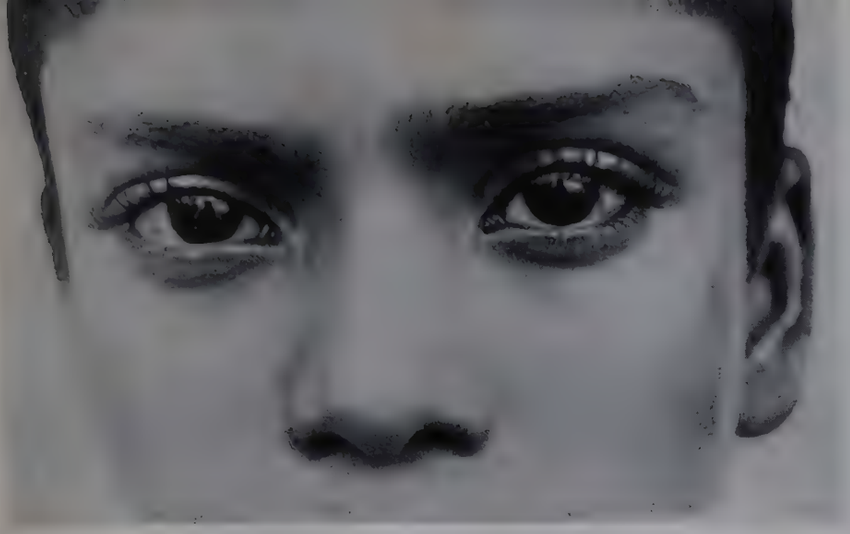
GROWTH OF CHILDREN RECOVERED FROM KWASHIORKOR



HYPOVITAMINOSIS A

Vitamin A deficiency is one of the main causes of blindness in India. One out of every four cases of blindness is preventable and is due to dietary deficiency of vitamin A. The peak incidence is in the age group 1 to 5 years. In older groups of population like school-age children, adolescents and pregnant women, this condition is also prevalent, but rarely leads to complete blindness.

The earliest symptom is inability to see in darkness (night blindness); the earliest clinical sign is dryness of the conjunctiva (conjunctival xerosis) which in addition appears muddy and wrinkled. Very often this is associated with triangular, foamy white and raised plaques on the temporal side of the cornea, called Bitot's spots.



VITAMIN A DEFICIENCY

Bitot's Spots are raised, triangular, foamy patches on the conjunctiva. They are signs of deficiency of Vitamin A. Generally they appear in both eyes, on the temporal side of the cornea. They may occasionally appear in only one eye.

Bitot's Spots : Note the foamy appearance.

Bitot's spot : Note the elevated, rough, dry spot on the temporal side of the cornea.

Keratomalacia : Note the ground glass appearance of both the corneae. These changes are irreversible and have made the child totally blind.

When in addition, the cornea is affected (xerosis corneae) softening of the cornea (keratomalacia) is likely to follow which if not promptly treated leads to necrosis and ulceration thus making the child completely blind.

The most rational method of prevention of this deficiency among the poor is to encourage the use of green leafy vegetables, which are inexpensive and rich sources of β-carotene- a precursor of this vitamin. Studies conducted by the Nutrition Research Laboratories indicate that as a short term measure, a massive single oral dose of 200,000 i.u. of vitamin A twice a year to pre-school children will help in the protection of the children from hypovitaminosis A and its ill effects.

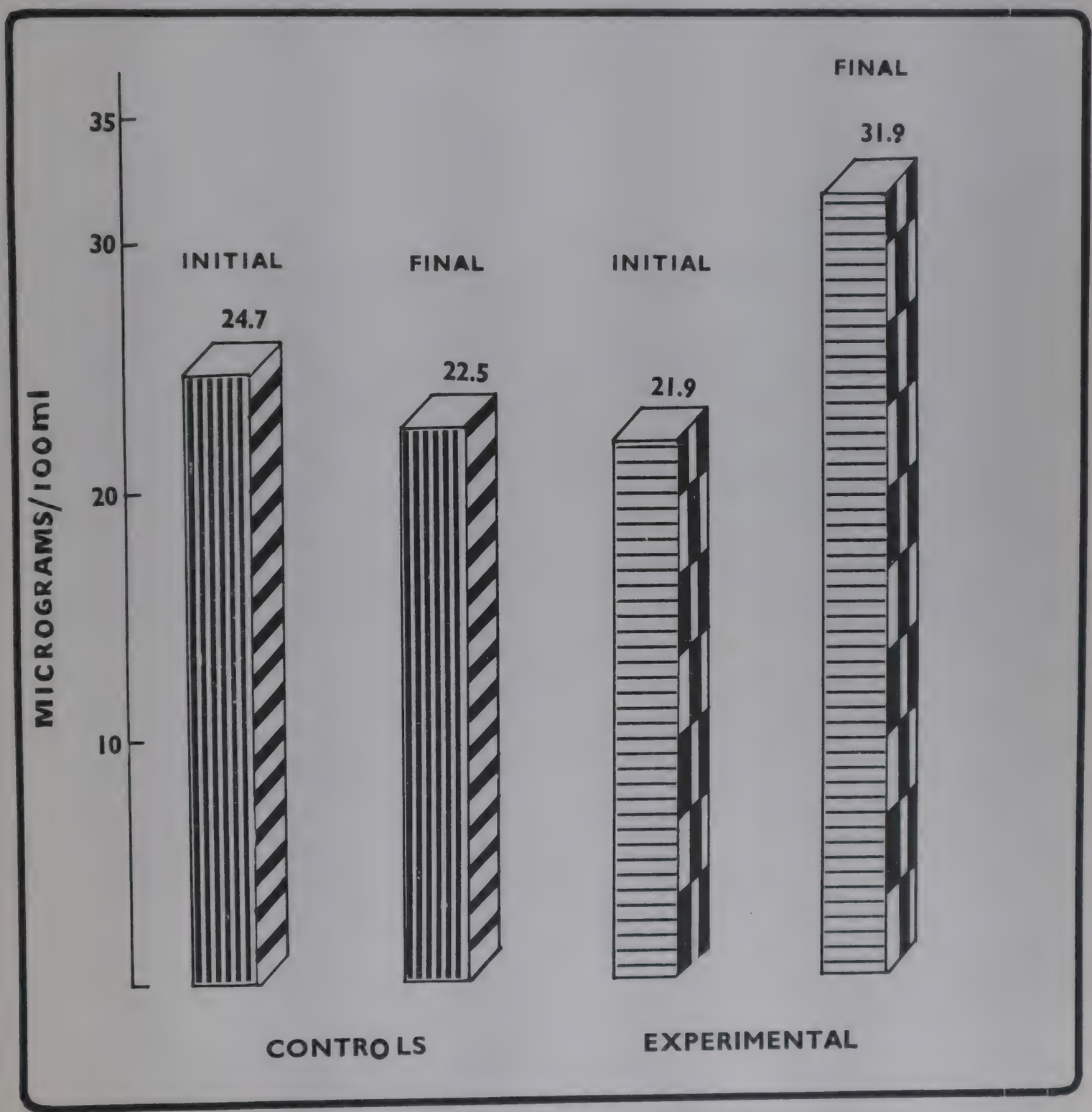
EFFECT OF FEEDING GREEN LEAFY VEGETABLES ON SERUM VITAMIN A

Vitamin A deficiency is one of the most important public health problems of India. The incidence is particularly high among pre-school children belonging to the poor income groups and is principally due to grossly inadequate dietary intake of vitamin A by them.

The most rational method of prevention of vitamin A deficiency in children would be to improve the diets consumed by them, so as to ensure adequate intakes of vitamin A. Studies conducted by Nutrition Research Laboratories and elsewhere have indicated that by encouraging the consumption of green leafy vegetables, which are cheap and rich sources of pro-vitamin A, the incidence of vitamin A deficiency can be lowered considerably among the poor communities without introducing any other dietary change.

Source: Vinod R. Lala and Vinodini Reddy, (December, 1969) *Amer. J. Clin. Nutr.*

EFFECT OF FEEDING GREEN-LEAFY VEGETABLES ON SERUM VITAMIN A*



* 40gms OF AMARANTH FOR 15 DAYS

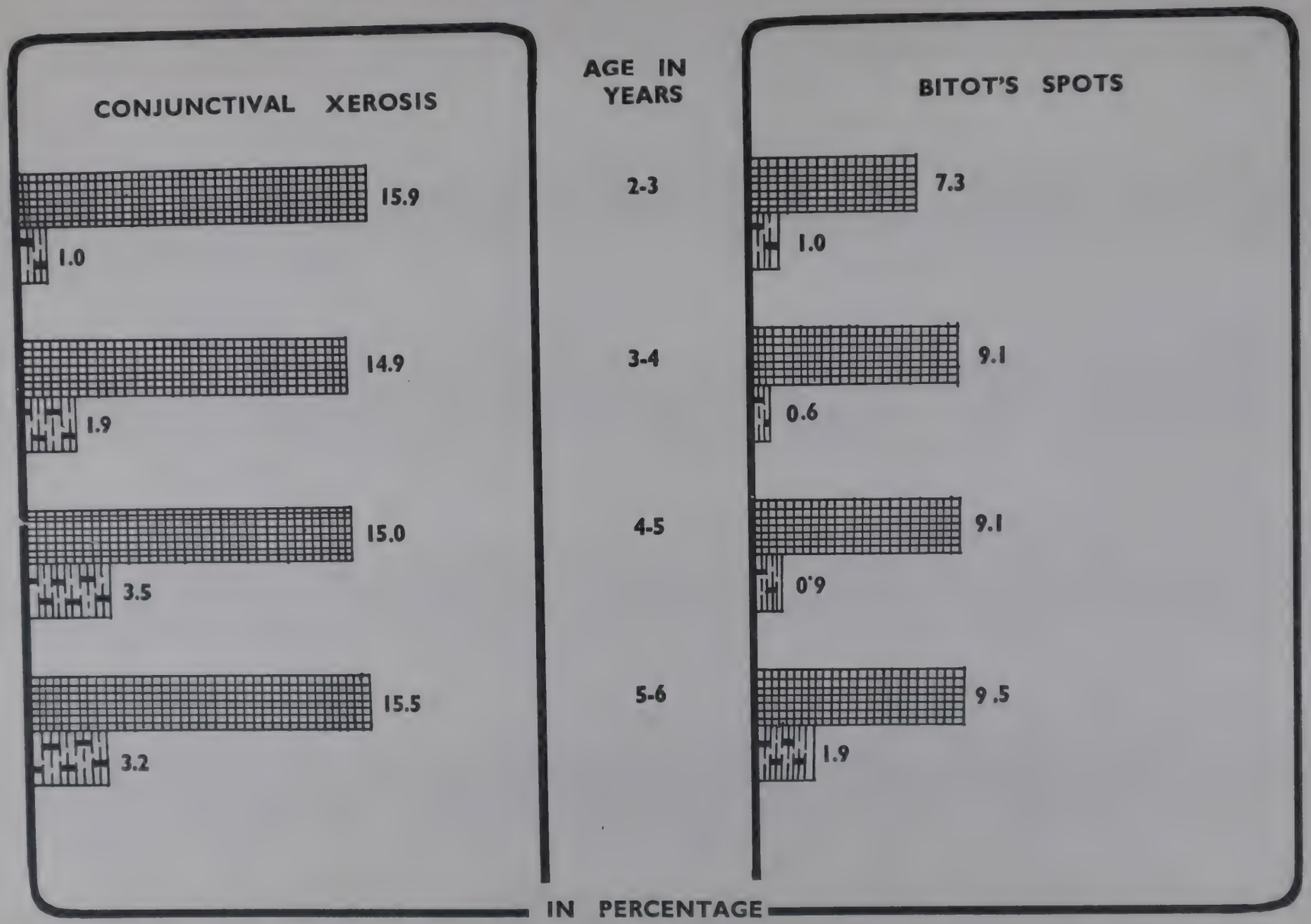
EFFECT OF AN ANNUAL MASSIVE SINGLE ORAL DOSE OF VITAMIN A ON THE INCIDENCE OF VITAMIN A DEFICIENCY SIGNS

To protect the pre-school children from the ill effects of vitamin A deficiency, apart from improvement of the dietaries, the conventional method of combating vitamin A deficiency in growing children is to give them frequent supplements of vitamin A. However, this can be expensive and impracticable. Since vitamin A is stored in the liver, one practicable method of prevention of this deficiency would be the administration of large doses of vitamin A to the children to build up their liver reserves.

Field studies conducted so far, indicate that administration of 200,000 i. u. of vitamin A in oil miscible form once every six months, can prevent vitamin A deficiency considerably.

Source : Swaminathan, M. C., Susheela, T. P. and Thimmayamma, B. V. S. (December, 1969). *Amer. J. Clin. Nutr.*

EFFCT OF AN ANNUAL MASSIVE SINGLE ORAL DOSE OF VITAMIN A 300,000 I.U. ON THE INCIDENCE OF VITAMIN A DEFICIENCY SIGNS



GEOGRAPHIC DISTRIBUTION OF ENDEMIC GOITRE, LATHYRISM, FLUOROSIS AND PELLAGRA

Some nutritional disorders are endemic in certain parts of the country.

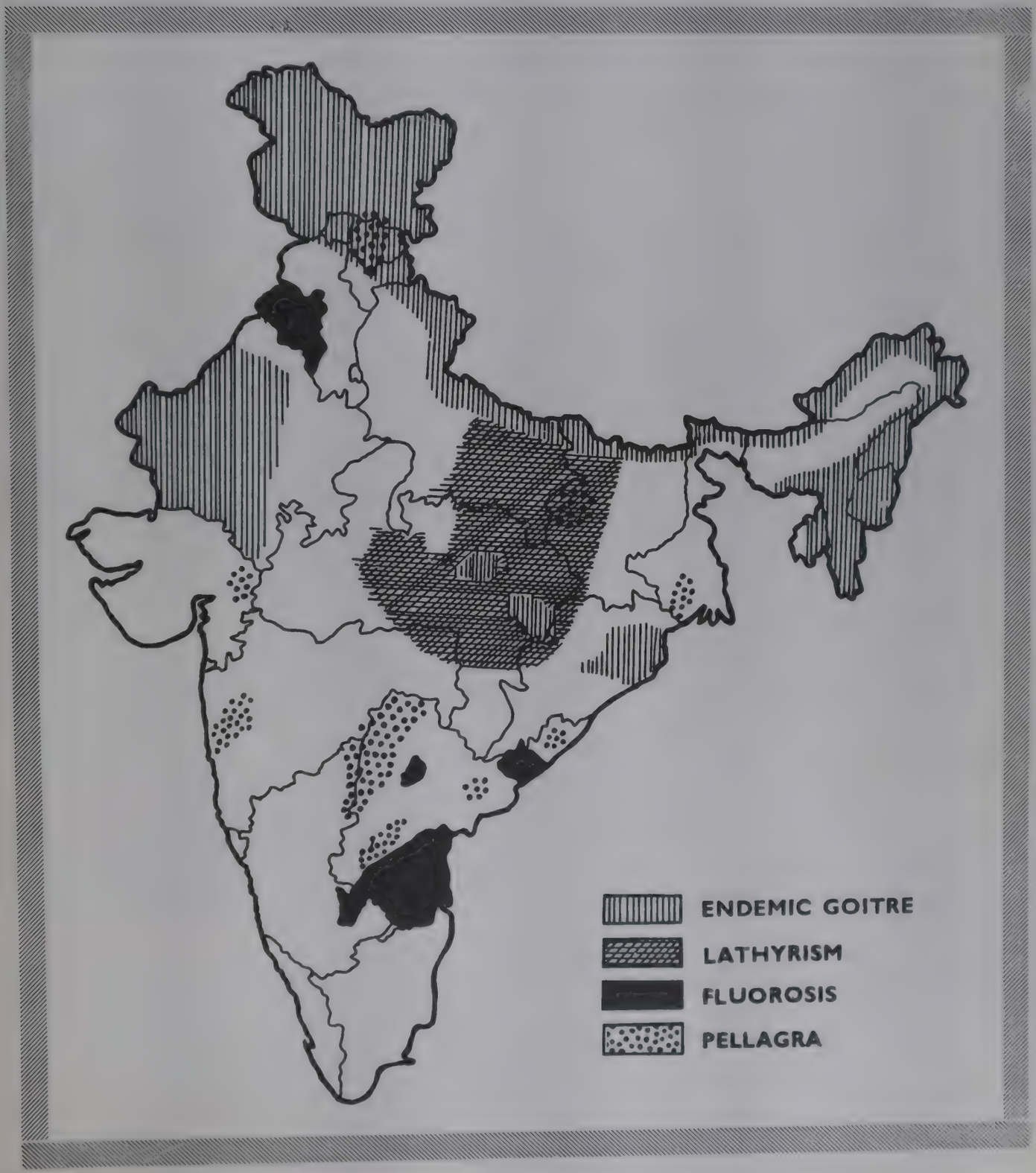
Endemic goitre, arising from deficiency of iodine, continues to be a major public health problem along the Sub-Himalayan belt.

Lathyrism, a disabling paralytic disorder caused by the excessive consumption of Khesri dhal (*Lathyrus sativus*) is endemic in Central India, in Madhya Pradesh, Eastern Uttar Pradesh and adjoining parts of Bihar.

Skeletal fluorosis, a crippling disorder due to excessive consumption of fluoride in water is endemic in parts of Andhra Pradesh and Punjab.

Pellagra, a deficiency of nicotinic acid, though reported from many parts of India, is peculiar to the Deccan plateau where jowar forms the staple.

GEOGRAPHIC DISTRIBUTION OF ENDEMIC GOITRE, LATHYRISM, FLUOROSIS, AND PELLAGRA.



PELLAGRA

Pellagra has long been known as a classical nutritional deficiency disease affecting poor population groups subsisting on maize diets. The disease is rare in areas where rice or wheat is the staple. On the other hand, pellagra is common in the Deccan Plateau of India, where it accounts for nearly 1 percent of all general hospital admissions and nearly 8 to 10 percent of admitions to mental hospitals in Hyderabad. A careful examination of the poor segments in this region, however, shows that the staple is not maize but the millet JOWAR (*Sorghum vulgare*). Both jowar and maize have however one common feature with regard to their amino acid composition: a high content of leucine. Researches conducted at the Nutrition Research Laboratories have provided strong evidence of role of leucine in the pathogenesis of pellagra in jowar eaters.

The disease is characterised by skin disorders (dermatitis), mental derangement (dementia) and gastro-intestinal disturbances (diarrhoea).

Fortunately, the leucine content of different strains of maize and jowar show wide variations. Thus the Opaque-2 strain of maize is not only high in lysine but also low in leucine. Identification of low leucine strains of these millets and the selective propagation of such strains would be a logical approach in the prevention of pellagra among the poor population groups.

FLUOROSIS

Fluorosis is a condition resulting from the excessive consumption of fluoride. Surveys conducted in certain parts of India point out that fluorosis is a problem of considerable magnitude with its ill effects in parts of Andhra Pradesh, Punjab and Mysore. The main source of this excess of fluoride is water.

Supply of protected water and Defluoridation of water are the most rational ways of preventing fluorosis. On small scale this could be done at domestic level by treating water with activated charcoal. At the village level this procedure can be adopted by treating water with burnt paddy husk.

Pellagra : Bilateral, symmetrical skin changes on the exposed parts are characteristic of pellagra. Note such changes on the face, chest and hands. This subject also shows cheilosis and stomatitis - signs of riboflavin deficiency.

Fluorosis : Changes in the teeth are early signs of fluorosis. Note the mottled enamel, seen as dark transverse bands, particularly on the upper incisors.

Lathyrism : Excessive consumption of Khesaridhal *(L. sativus)* leads to spastic paraplegia. Note the stiffness of the lower extremities, which ultimately leads to permanent crippling.

Goitre : Deficiency of iodine leads to enlargement of the thyroid gland. It may some times grow to a very large size as seen here.

LATHYRISM

This is a crippling paralytic disorder associated with the excessive consumption of Khesari dhal (*Lathyrus sativus*) and is widely prevalent in central India. Higher incidence is observed among males and young adults. Experiments so far conducted have revealed that this condition is due to the presence of a neurotoxic factor - BOAA (βoxalyl amino alanine) in the pulse. Onset of the disease is gradual. Weakness of the lower limbs is first felt and later spasticity of several muscles develops, ending in paralysis. This disease can be prevented by propagating certain strains of *lathyrus* now identified as having either no toxin or contain it in non-toxic amounts.

It is possible to eliminate the toxin by steeping the dehusked pulse in hot water for about 2 hours, discarding the steep water and sun drying the dhal before use.

ENDEMIC GOITRE

Endemic goitre is due to deficiency of iodine and is widely prevalent all along the Sub-Himalayan belt. The highest prevalence is observed in girls between 12 and 18 years of age and in boys beetween 9 and 13 years of age.

"Simple goitre is the easiest of all known diseases to prevent and it may be excluded from the list of human diseases as soon as society determines to make effort" as Marine has described it. It is generally accepted that the most practicable method of providing supplementary iodine is the iodisation of salt. Preliminary surveys carried out in this regard have indicated that the iodisation of salt can reduce the incidence of endemic goitre by about 60 %.

EFFECT OF IODISATION OF SALT ON THE INCIDENCE OF ENDEMIC GOITRE

One of the effective methods to prevent endemic goitre is to enrich common salt with iodine.

A five year study conducted in the goitrous zone of Kangra Valley has revealed that iodisation of salt (enrichment of salt with iodine)has reduced the incidence of goitre from about 40% to about 17%, a reduction of nearly 60%.

Based on the preliminary report by Sooch and Ramalingaswamy 1965. *Bulletin W.H.O.* **32**, 299.

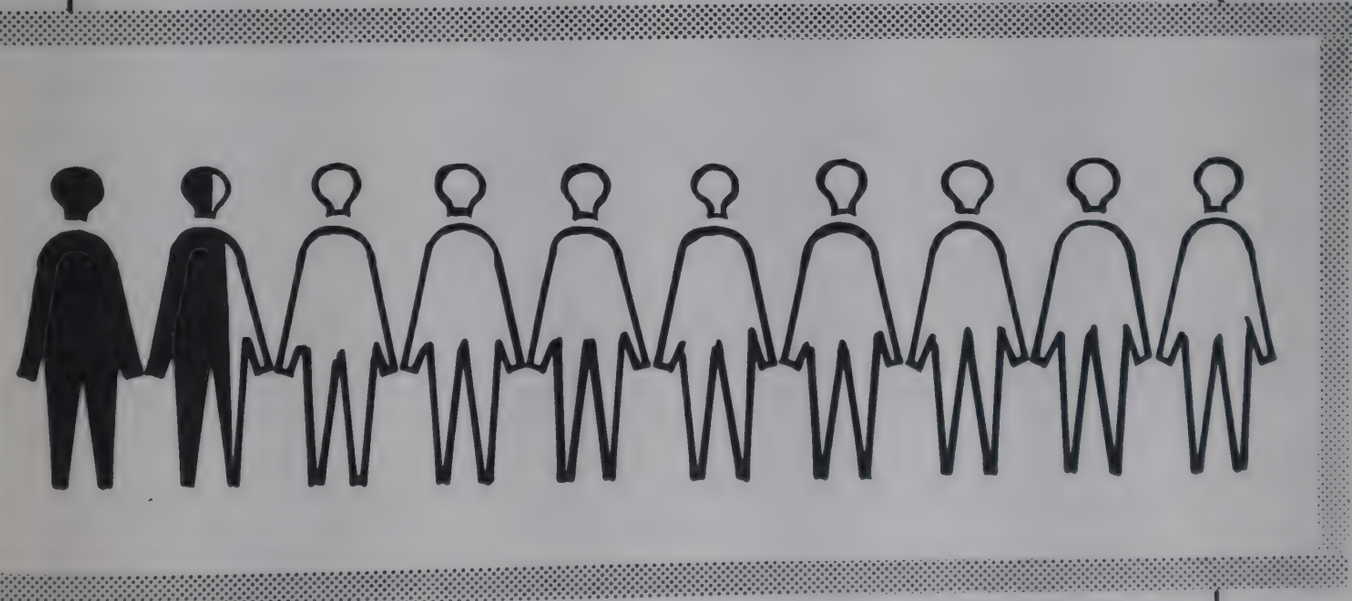
EFFECT OF IODISATION OF SALT ON THE INCIDENCE OF GOITRE

BEFORE IODISATION

Out of ten persons FOUR had GOITRE

AFTER IODISATION

Out of ten persons only TWO have GOITRE



Consumption of Salt enriched with Iodine reduced the incidence of Goitre from 40.1% to 16.8%

TRIBES

According to 1961 Census of India, scheduled tribes accounted for about 30.2 millions and formed about 7 percent of the total population of the country.

Nutrition and Diet surveys on tribal populations are few. Surveys so far conducted on Abors of Assam region, Monpas of NEFA, Santals and Paharias in Bihar, Onges in the little Andamans, Dublas and Warlis in Maharashtra and Uralis and Kanikkars of Travancore hills indicate that in general, these tribals are heavier but shorter and their strength and endurance are generally superior to those of the civilised people.

The major nutritional deficiency signs encountered in the Monpas were goitre and angular stomatitis whereas in Onges, signs of vitamin A deficiency were observed in children.

DROUGHT AREAS

Results of surveys conducted in several drought affected areas of Andhra Pradesh, Bihar and Mysore show that, as might be expected, the common nutritional deficiency signs which are observed in the general population are encountered to a greater extent.

SPECIAL GROUPS OF POPULATIONS
ON WHOM NUTRITION SURVEYS HAVE BEEN DONE

APPENDIX

THE UNITS OF EXPRESSION OF THE VARIOUS ANTHROPOMETRIC MEASUREMENTS PRESENTED IN THIS ATLAS ARE AS FOLLOWS:

Crown – Heel length or Standing Height	...	cm
Crown – Rump length or Sitting Height	...	cm
Weight	...	kg
Arm circumference Calf circumference Head circumference Chest circumference Bicristal diameter Hip width	...	cm
Fat fold at biceps Fat fold at triceps Fat fold at calf	...	mm

TABLE 1

MEAN HAEMOGLOBIN LEVELS IN PREGNANT WOMEN

Source	Period of gestation	Number	Hb.g%	Reference No.
Kathiagani et al	...	50	10.7	1
Krishna Menon	...	175	10.1	2
Das Gupta	1st Trimester	...	11.4	3
URBAN	2nd Trimester	...	11.4	
	3rd Trimester	...	11.3	
RURAL			11.1	
	9–14 wks.	...	12.8	4
Venkatachalam	15–24 ,,	...	11.6	
	25–36 ,,	...	11.2	
Rami et al	...	272	10.8	5
Kothari and Bhende	...	19	10.8	6
Ganguli	...	74	10.6	7
Kalpakam Shankar	8–16 wks.	35	11.4	8
	17–24 ,,	133	10.3	
	25–40 ,,	236	9.9	
NutritionResearchLaboratories	...	456	11.2	9
Swaminathan et al	...	82	10.9	10
Leela Iyengar	8–16 wks.	265	12.7	11
	17–24 ,,	503	12.0	
Swaminathan	...	1192	10.6	12

TABLE 2

FREQUENCY DISTRIBUTION OF HAEMOGLOBIN LEVELS IN PREGNANT WOMEN

Source	Total Number	Upto 7.9 g%	8–9.9 g%	10–11.9 g%	12 g% and above	Reference No.
Venkatachalam	...	15	60	166	152	4
Swaminathan *et al*	55	...	14	28	13	10
Kalpakam Shankar	394	...	179	215	...	8
Patwardhan	...	664	...	...	...	13
Kothari and Bhende	19	...	4	13	2	6
Swaminathan	1192	...	336	660	196	12
Leela Iyengar	768	24	75	669	...	11
Rami *et al*	272	...	60	161	51	5
Joshi *et al*	127	...	35	65	27	14
Vellore	1008	150	...	410	440	
Delhi	1348	...	...	930	418	15
Delhi	100	17	30	40	13	
Vellore	1000	15	20	35	18	
Sood and Ramalinga	848	...	...	738	110	16
Swami	500	...	...	447	53	
	151	...	...	140	11	

TABLE 3

MEAN HAEMOGLOBIN LEVELS IN LACTATING WOMEN

Source	Number	Hb. g%	Reference
Kalpakam Shankar	34	11.8	i
Swaminathan *et al*	251	11.7	ii
Jayalakshmi *et al*	50	10.8	iii

References : i) Kalpakam Shankar, (1962) Ind. J. Med. Res., 50; 113.

ii) Swaminathan, M. C., Apte, S. V. and Someswara Rao, K. (1960) *Ind. J. Med. Res.* **48:** 762.

iii) Jayalakshmi, V. T., Ramanathan, M. K. and Gopalan, C. (1957) *Ind. J. Med. Res.* **45:** 605.

TABLE 4

INCREASE IN BODY WEIGHT (kg) DURING PREGNANCY IN INDIAN WOMEN OF THE LOW INCOME GROUP

Term in Weeks	12–16	16–20	20–24	24–28	28–32	32–36	36–40
Primi gravidae : Number	13	13	24	24	24	24	13
Mean	0.30	0.84	1.52	0.85	0.64	0.74	0.28
Multi gravidae : Number	35	76	106	106	106	106	45
Mean	1.10	1.12	1.46	0.96	0.95	0.79	0.35

Reference: Venkatachalam, P. S. (1960) *Ind. J. Med. Res.* **48** : 511.

TABLE 5

EFFECT OF VITAMIN A SUPPLEMENTATION TO PREGNANT WOMEN ON CORD BLOOD LEVELS OF VITAMIN A

	Number	Carotene μg%	Serum Vitamin A μg%
III Trimester	33	99.0	22.4
Neonates of mothers without Vitamin A Supplementation	43	24.1	16.6
Neonates of mothers with Vitamin A Supplementation *	12	21.3	28.1

* daily oral supplement of 10,000 μg (30,000 i. u) of vitamin A.

Reference : Venkatachalam, P.S., Bhavani Belavady and Gopalan, C. (1962) *J. Pædiatrics*, **16** : 262.

TABLE 6

EFFECT OF PROTEIN SUPPLEMENTATION TO PREGNANT WOMEN ON CORD BLOOD LEVELS OF PROTEIN

	No.	Maternal Plasma		Cord Plasma		Birth Weight: g	Gain in Maternal Weight : kg%
		Total Protein: g%	Albumin: g%	Total Protein: g%	Albumin: g%		
Non-Pregnant	22	7.00 ± 0.80	3.61 ± 0.07	...	...	...	...
Pregnant : home diet	26	6.25 ± 0.128	2.58 ± 0.068	5.34 ± 0.27	3.10 ± 0.166	2704 ± 24	+0.35
Pregnant : hospital diet	13	6.25	2.72	6.11	3.56	3028	+1.27
Pregnant : hospital diet +100 g skim milk	12	6.41	2.72	6.09	3.48	3028	+1.23

* All values are Means ± S. E.

Reference : Leela Iyengar (1967) *Ind. J, Med. Res.* **55 : 85.**

TABLE 7

OUTPUT OF BREAST MILK AT DIFFERENT STAGES OF LACTATION

Weeks of Lactation	1	2	3	4	6	10	12	14	16	18	20	22	24
Mean milk out-put (ml)	454	476	479	496	499	473	471	516	527	513	454	505	516
Mean weight of Infant (g)	2778	2920	3119	3260	3714	4196	4394	4564	4820	5103	5338	5557	5755

Reference : Gopalan, C. (1958) *J. Trop. Paed.* **4** : 87.

Months of Lactation	0–2	3–4	5–6	7–8	9–10	11–12	13–15	16–18	19–24	25–36	37–48
Number examined	20	18	14	14	17	30	11	29	14	12	4
Mean out put of breast milk (ml)	530	640	730	660	600	525	515	440	400	425	345

Reference : Someswara Rao, K., Swaminathan, M. C., Swarup, S. and Patwardhan, V. N. (1959) *Bull. Wld. Hlth. Org.* **20** : 603.

TABLE 8

COMPOSITION OF BREAST MILK AT DIFFERENT STAGES OF LACTATION

Nutrients	1st and 2nd day	3–10 days	11–30 days	2–6 months	7–12 months	13–18 months	18 months and above	5–13 months	after 1st month	Todas	Kotas	Irulas
Protein : g	8.36	2.31	1.31	1.06	1.01	1.05	1.13	1.06	1.06	1.11	1.03	1.02
Fat : g	...	4.49	4.16	3.34	3.23	3.79	3.41	...	3.42	2.46	3.36	2.81
Lactose : g	...	7.40	7.41	7.47	7.54	7.54	7.51	7.47	7.51	7.49	7.41	8.07
Calories	...	76	65	64	63	69	66	...	...	57	64	59
Calcium : mg	...	...	...	...	...	...	...	36.3	34.2	26.2	26.6	23.5
Phosphorus : mg	...	...	...	...	...	...	...	11.7	11.9	13.1	13.7	13.7
Vitamin A : μg	...	114	40	26	22	22	22	26	23	13	8	15
Thiamine : μg	...	5.6	6.5	15.3	14.5	16.5	15 1	15.3	15.4	14.7	17.9	16.4
Riboflavin : μg	...	28.9	17.6	19.0	18.1	17.2	11.5	19.0	17.2	8.1	14.2	11.9
Ascorbic acid : mg	3.5	4.4	2.8	1.9	2.5	3.2	2.9	1.9	2.6	1.3	3.5	6.3
Ref. No.	1							2	3	4		

All values are per 100 ml milk

Reference:
1. Bhavani Belavady and Gopalan, C. (1959) *Ind. J. Med. Res.* **47** : 234.
2. Gopalan, C. (1958) *J. Trop. Paed.* **4** : 87.
3. Gopalan, C. and Bhavani Belavay, (1961) *Fed. Proc. (Suppl. No. 7)*, **20** : 177.
4. Bhavani Belavady, Pasricha. S. and Kalpakam Shankar (1959) *Ind. J. Med. Res.* **47** : 221.

TABLE 9

MATERNAL MORTALITY RATES / 100,000 LIVE BIRTHS IN SOME SELECTED COUNTRIES

U. S. A.	...	...	33.1
Denmark	...	...	15.6
Finland	...	...	42.3
Netherlands	...	...	33.1
Sweden	...	...	19.6
England and Wales	...	...	25.9
Northern Ireland	...	...	17.5
Scotland	...	...	23.0
Australia	...	...	32.7
Newzealand	...	...	32.2
India *	...	...	253.0

Source : Roma N. Chamberlain (1969) *British Medical Bulletin*, **24** : 87.

* From *Vital Statistics of India* (1963–64).

TABLE 10

BIRTH WEIGHTS IN DIFFERENT STATES IN INDIA

Place of Study	State	Sex	Economic Status	Number	Mean Birth Weight : g	Reference
Secunderabad	Andhra Pradesh	Pooled	...	10,000	2897	17
Hyderabad	Andhra Pradesh	Males	Poor	109	2731	18
		Females	Poor	88	2616	
Patna	Bihar	Males	...	450	2714	19
		Females	...	347	2672	
	Bihar and West Bengal	Pooled	...	355	2640	20
New Delhi	Delhi	Pooled	Poor	110	3000	21
		Pooled	Poor	792	3100	
New Delhi	Delhi	Males	Poor	1,338	2778	22
		Females	...	1,357	2721	
Trivandrum	Kerala	Males	...	6,448	2904	
		Females	...	6,192	2830	23
		Pooled	...	12,640	2868	
Coonoor,	Madras and	Pooled	Poor	1,598	2778	
Hyderabad and Madras	Andhra Pradesh	Pooled	Wealthy	484	3055	4
		Pooled	Poor		2810	
		Pooled	Wealthy		3182	
Coonoor	Madras	Pooled	Spl. Ward	200	3085	24
		Pooled	General Ward	500	2722	
Madras	Madras	Pooled	Poor	5,176	2736	25
		Pooled	Wealthy	512	2985	
Ootachmund	Madras	Males	...	701	2958	
		Females	...	631	2953	26
		Pooled	...	1,338	2953	

Gwalior	Madhya Pradesh	Males	...	1,499	2937	27
		Females	...	1,428	2847	
		Pooled	...	2,927	2893	
Dabra	Madhya Pradesh	Pooled	Poor	1,051	2762	28
Bombay	Maharastra	Males	...	10,971	2613	29
		Females	...	10,287	2568	
Bombay	Maharastra	Pooled	...	5,018	2613	30
Bombay	Maharastra	Males	Lower Economic	500	2634	31
		Females	,,	500	2522	
		Pooled	,,	1,000	2578	
		Males	Lower Middle Income	543	2873	
		Females	,,	457	2720	
		Pooled	,,	1,000	2796	
		Males	Upper Middle Income	500	2994	
		Females	,,	500	2745	
		Pooled	,,	1,000	2945	
		Males	Upper Income Group	...	3270	
		Females	,,	...	3225	
		Pooled	,,	270	3247	
Bombay	Maharastra	Males	Poor	32	2815	32
		Females	Poor	29	2712	
	Punjab	Pooled	...	...	2899	33
Agra	Uttar Pradesh	Males	...	251	3097	34
		Females	...	249	3039	
		Pooled	...	500	3069	
Kanpur	Uttar Pradesh	Males	...	530	2514	35
		Females	...	470	2458	
		Pooled	...	1,009	2488	
Calcutta	West Bengal	Males	Poor	538	2729	36
		Females	,,	500	2683	
		Pooled	,,	871	2656	
		Pooled	Paying Patients Ward	160	2851	

TABLE 11

ANTHROPOMETRIC MEASUREMENTS AT BIRTH

Place of Study	State	Sex	Number	Crown-Heel length	Crown-Rump length	Head circum-ference	Chest circum-ference	Bicristal diameter	Fat fold at triceps	Fat fold at calf	Reference No.
	Bihar and West Bengal		355	47.63	...	32.89	...	...	...	...	20
New Delhi	Delhi		110	49	...	33.25	29.5	...	...	...	21
Kanpur	Uttar Pradesh	Males	530	47.83	31.32	32.97	30.45	...			
		Females	470	47.12	30.92	32.66	29.96	...	...	...	35
		All average	1009	47.49	31.13	32.82	30.22	...			
New Delhi	Delhi	Males	1338	48.54	...	33.45	...	...	...	...	22
		Females	1357	48.11	...	33.15	...	...			
Hyderabad	Andhra	Males	109	48.5	31.4	33.5	30.5	7.5	4.8	5.2	18
	Pradesh	Females	88	47.7	31.2	32.6	30.2	7.2	5.0	5.3	
Bombay	Maharastra	Males	32	46.68	...	32.74	32.33	...	...	...	32
		Females	29	46.63	...	31.98	32.79	...			
New Delhi	Delhi	Males	56	48.33	32.43	33.93	31.15	...	...	...	37
		Females	55	48.02	31.47	33.42	31.05	...			
Bombay	Maharastra	Males	43	49.61	...	34.04	31.65	...	...	...	38
		Females	39	48.77	...	33.76	31.24	...			

TABLE 12

INFANT AND TODDLER MORTALITY RATES IN DIFFERENT COUNTRIES

Developed Countries	I. M. R.	T. M. R.	Developing Countries	I. M. R.	T. M. R.
Australia	19.1	1.0	Colombia	90.0	15.6
Belgium	25.8	1.0	El Salvador	65.5	22.7
Canada	24.7	1.1	Guatemala	91.6	42.7
France	23.4	1.2	Guinea	42.0	55.4
Japan	20.4	1.9	Mexico	66.3	14.7
Netherlands	14.8	1.1	Costa Rica	86.4	N.A.
Sweden	14.2	0.8	Honduras	50.0	13.5
U. S. A.	24.8	1.0	Venezuela	48.0	5.5
			India	81.0	12.0
			Malaya	57.0	34.0
			Philippines	67.4	8.1

I. M.R. = Infant Mortality Rate per 1,000 live births.

T. M. R. = Toddler Mortality Rate per 1,000 population.

TABLE 13

PERCENTAGE OF INFANT DEATHS IN VARIOUS AGE PERIODS IN DIFFERENT STATES IN INDIA

State	I Within 1 week of birth	II Between 1 week and 1 month	III Between 1 month and 6 months	IV Between 6 months and 12 months
Andhra Pradesh	26	18	30	26
Bihar	35	19	27	19
Madras	19	28	24	29
Orissa	25	23	32	20
Uttar Pradesh	19	15	30	36
Punjab	26	23	27	24
West Bengal	26	22	34	18
India	24	20	29	27

Note: I + II = Neonatal Mortality

Source: *Vital Statistics of India*, 1962, p. XVI.

TABLE 14

DEVELOPMENTAL MILESTONES IN AND BRITISH INFANTS

	Indian	British
HOLDING THE HEAD:		
Chin slightly off ground	4 Weeks	4 Weeks
Chin at 45° angle from ground	8 "	8 "
Chin at 45–90° angle from ground	12 "	12 "
Chin at 90° angle from ground	16 "	16 "
Sitting with support	20.5 "	28 "
Sitting with-out support	26 "	36 "
Standing with support	22 "	24 "
Standing without support	34 "	36 "
Crawling on belly	26.3 "	40 "
Crawling on knees	32.4 "	44 "
Walking with support	45.1 "	48 "
Walking without support	52.4 "	55 "

Reference : Based on the studies Conducted in Nutrition Research Laboratories

TABLE 15

ANTHROPOMETRIC MEASUREMENTS OF INFANTS

MALES

Measurements	Age in months												Reference No.
	1	2	3	4	5	6	7	8	9	10	11	12	
Hyderabad													
C–H Length	...	56.0	...	60.5	...	63.6	...	65.6	...	67.4	...	68.9	
C–R Length	...	37.0	...	39.4	...	41.3	...	41.9	...	43.1	...	43.2	
Weight	...	4.5	...	5.6	...	6.5	...	6.6	...	7.0	...	7.1	39
Head Circumference	...	37.8	...	39.7	...	40.9	...	42.1	...	42.9	...	43.2	
Chest Circumference	...	35.9	...	38.2	...	39.6	...	40.4	...	41.2	...	41.1	
New Delhi													
C–H Length	54.01	56.78	60.21	...	...	65.02	...	...	68.74	...	...	73.39	
C–R Length	35.90	38.16	41.50	...	...	42.80	...	...	44.77	...	...	46.76	
Weight	3.88	4.69	5.70	...	...	7.04	...	...	7.98	...	...	8.91	37
Head Circumference	36.56	38.53	40.12	...	...	42.41	...	...	44.42	...	...	45.47	
Chest Circumference	35.32	37.43	39.54	...	...	42.10	...	...	43.97	...	...	45.85	
Bombay													
C–H Length	52 07	55.50	59.18	...	...	63.65	...	...	68.50	...	...	73.33	
C–R Length	...	...	...	...	...	...	...	...	...	...	...	...	
Weight	3.53	4.46	4.56	...	...	6.27	...	...	6.37	...	...	7.84	38
Head Circumference	37.11	39.17	39.95	...	...	42.37	...	...	44.45	...	...	45.74	
Chest Circumference	35.05	38.20	38.79	...	...	40.82	...	...	42.49	...	...	44.75	

Bombay (Sweeper Community)													
C–H Length	51.61	54.97	56.92	58.42	60.55	61.59	62.84	64.24	65.40	66.17	67.23	69.75	
C–R Length	...	...	...	...	...	...	...	...	...	...	...	...	
Weight	3.33	3.96	4.52	5.12	5.57	6.01	6.18	6.63	6.67	6.95	7.14	7.47	32
Head Circumference	34.62	36.22	38.12	39.01	39.90	40.77	41.15	41.83	42.72	43.03	43.54	44.02	
Chest Circumference	33.30	35.28	36.55	38.15	38.66	39.52	40.72	41.35	42.04	42.47	43.20	44.07	
I. C. M. R.													
C–H Length	...	56.2	...	...	62.7	...	...	64.9	...	...	69.5	73.9	
C–R Length	...	36.2	...	...	41.8	...	...	42.3	...	...	43.4	45.4	
Weight	...	4.5	...	...	6.7	...	...	6.9	...	...	7.4	8.4	40
Head Circumference	...	38.6	...	...	41.3	...	...	42.6	...	...	43.7	44.4	
Chest Circumference	...	36.0	...	...	39.4	...	...	41.1	...	...	42.2	43.3	
Rural Hyderabad													
C–H Length	52.3	55.2	57.8	60.3	61.9	63.4	64.6	66.0	66.2	67.3	68.3	69.8	
C–R Length	34.2	36.1	38.0	39.4	40.5	41.3	41.9	42.6	42.6	43.2	43.7	44.2	
Weight	3.6	4.3	5.0	5.4	6.0	6.4	6.5	6.9	6.9	7.0	7.2	7.4	41
Head Circumference	36.0	37.6	39.1	40.1	41.1	41.6	42.3	42.9	42.9	43.2	43.8	44.2	
Chest Circumference	33.9	36.1	38.0	39.1	39.7	40.3	41.0	42.1	41.6	42.5	44.1	43.3	

TABLE 16

ANTHROPOMETRIC MEASUREMENTS OF INFANTS

FEMALES

Measurements	Age in months												Reference No.
	1	2	3	4	5	6	7	8	9	10	11	12	
Hyderabad													
C–H Length	...	54.2	...	58.1	...	61.0	...	63.3	...	65.5	...	67.3	
C–R Length	...	35.0	...	37.6	...	40.0	...	40.9	...	42.2	...	42.6	
Weight	...	4.1	...	4.9	...	5.4	...	5.9	...	6.2	...	6.5	39
Head Circumference	...	36.6	...	38.0	...	39.7	...	40.5	...	41.8	...	42.3	
Chest Circumference	...	34.4	...	36.1	...	37.5	...	38.4	...	39.8	...	40.3	
New Delhi													
C–H Length	53.08	55.36	58.54	...	...	63.69	...	...	67.60	...	...	72.31	
C–R Length	35.39	36.62	38.69	...	...	42.12	...	...	44.17	...	...	45.98	
Weight	3.77	4.26	5.21	...	...	6.71	...	...	7.49	...	...	8.43	37
Head Circumference	36.00	37.76	39.13	...	...	41.90	...	...	43.25	...	...	45.00	
Chest Circumference	33.68	36.10	38.10	...	...	41.50	...	...	43.17	...	...	45.10	
Bombay													
C–H Length	...	55.88	59.36	...	...	62.38	...	...	66.95	...	...	72.08	
C–R Length	...	...	...	...	...	...	...	...	...	...	...	...	
Weight	...	4.39	4.56	...	...	5.54	...	...	5.92	...	...	7.55	38
Head Circumference	...	36.19	38.81	...	...	40.84	...	...	42.60	...	...	44.45	
Chest Circumference	...	38.73	39.06	...	...	39.83	...	...	41.60	...	...	43.94	

Bombay (Sweeper Community)													
C–H Length	50.34	52.86	54.84	57.89	58.47	60.27	61.16	62.05	63.50	64 54	65.40	66.70	
C–R Length	...	...	...	...	...	...	...	...	...	...	...	...	
Weight	3.29	3.95	4.82	5.01	5.50	5.79	5.99	6.21	6.36	6 52	6.72	7.01	32
Head Circumference	34.47	36.58	37.67	38.51	39.52	40.21	40.72	41.45	41.99	42.54	43.03	43.51	
Chest Circumference	33.83	35.33	37.26	38.18	39.24	39.75	40.21	40.44	41.78	42.57	42.70	44.70	
I. C. M. R.													
C–H Length	...	55.0	...	...	60.9	...	...	64.4	...	...	66.7	72.5	
C–R Length	...	35.3	...	...	39.1	...	...	40.9	...	...	42.1	44.2	
Weight	...	4.2	...	...	5.6	...	...	6.2	...	...	6.6	7.8	40
Head Circumference	...	37.7	...	...	40.6	...	...	41.7	...	...	42.4	43.6	
Chest Circumference	...	34.7	...	...	38.0	...	...	39.5	...	...	40.5	42.3	
Rural Hyderabad													
C–H Length	51.6	54.7	57.6	59.5	61.0	62.4	63.5	64.1	65.7	66.5	66.7	67.3	
C–R Length	33.7	36.0	37.8	39.2	40.1	40.8	41.4	41.6	42.4	42.7	42.8	43.1	
Weight	3.4	4.1	4.8	5.2	5.6	5.9	6.2	6.2	6.5	6.5	6.7	6.6	41
Head Circumference	35.1	36.5	38.0	38.9	39.6	40.2	41.0	41.3	41.8	42.1	42.3	42.5	
Chest Circumference	33.3	35.3	37.1	38.0	38.7	39.4	40.2	40.1	40.9	41.2	41.0	41.1	

TABLE 17

ANTHROPOMETRIC MEASUREMENTS OF PRE-SCHOOL CHILDREN BY AGE AND SEX IN DIFFERENT PARTS OF INDIA

Place	MALES — Age in years					Measurements	FEMALES — Age in years					Reference No.
	1	2	3	4	5		1	2	3	4	5	
Hyderabad	73.3	78.1	84.9	91.9	...	Height	71.7	77.7	83.3	90.4	...	42
	43.9	46.5	49.2	52.1	...	Sitting Height	43.0	45.6	48.3	51.2	...	
	8.0	9.4	11.1	12.6	...	Weight	7.5	9.0	10.5	12.1	...	
	44.4	45.5	46.8	47.5	...	Head Circumference	43.3	44.8	45.7	46.8	...	
	42.4	44.3	46.8	48.4	...	Chest ,,	41.2	43.5	45.3	47.3	...	
	12.4	12.6	13.6	13.8	...	Arm ,,	12.2	12.5	13.3	13.8	...	
	15.2	15.8	17.4	18.3	...	Calf ,,	14.9	15.8	17.0	18.0	...	
	6.8	7.1	7.6	7.3	...	Fat fold at Triceps	7.0	7.2	8.0	8.0	...	
	10.1	9.7	9.8	9.1	...	,, at Calf	10.0	9.8	9.9	9.2	...	
Nilgiris	...	74.9	82.5	89.9	96.0	Height	...	74.2	83.3	88.6	94.2	43
	...	7.8	10.2	11.7	13.2	Weight	...	7.2	9.7	11.2	12.5	
	...	12.2	13.7	14.6	14.7	Hip Width	...	12.1	13.1	13.8	15.2	
	...	6.53	5.8	5.5	5.0	Fat fold at Biceps	...	6.6	9.9	9.7	8.7	
	...	10.0	9.5	8.5	8.7	Fat fold at Triceps	...	9.4	6.2	5.9	5.1	
Bombay	73.3	81.5	88.1	95.2	101.9	Height	72.1	80.4	86.1	95.5	99.8	38
	7.8	9.6	11.5	12.7	14.3	Weight	7.5	9.4	10.7	12.3	13.9	
	45.7	47.3	48.5	49.3	50.3	Head Circumference	44.4	46.0	47.5	48.1	48.8	
	44.7	47.8	49.8	50.9	52.9	Chest ,,	43.9	47.0	48.1	50.6	53.3	

	73.4	84.2	89.7	96.2	105.0	Height	72.3	82.4	86.8	97.0	103.9	
	46.8	51.5	52.0	55.3	57.3	Sitting Height	46.0	50.2	51.8	56.1	56.2	
New Delhi	8.9	11.5	12.5	14.9	17.7	Weight	8.4	10.3	11.9	15.1	17.1	37
	45.5	48.2	48.8	49.8	50.0	Head Circumference	45.0	47.2	46.1	49.4	50.1	
	45.8	49.3	49.4	51.6	53.6	Chest ,,	45.1	47.8	49.4	52.5	54.3	
Hyderabad	70.2	78.1	86.1	92.5	...	Height	69.4	76.7	84.9	91.5	...	44
	7.4	9.1	11.0	12.3	...	Weight	7.1	8.5	10.5	12.0	...	
	73.9	81.6	88.8	96.0	102.1	Height	72.5	80.1	87.2	94.5	101.4	
	45 4	48.7	51.6	54.5	57.0	Sitting Height	44.2	47.5	50.3	53.3	56.0	
All India	8.4	10.1	11.8	13.5	14.8	Weight	7.8	9.6	11.2	12.9	14.5	
	12.1	13.5	14.7	15.7	16.4	Bicristaldiameter	11.7	13.2	14.4	15.4	16.3	40
	44.4	45.9	47.3	48.0	48.5	Head Circumference	43.6	45.2	46.2	47.1	47.8	
	43.3	45.8	48.0	49.4	50.8	Chest ,,	42.3	45.2	47.2	48.7	50.1	
Madras State	...	82.8	88.9	93.0	103.4	Height	...	81.8	82.8	82.5	105.2	45
	...	9.9	11.6	13.1	15.4	Weight	...	9.9	12.1	12.2	14.1	
Ankola	76.1	83.4	87.8	94.6	101.3	Height	74.5	81.1	86.1	98.5	99.7	39
	9.8	11.1	12.1	13.9	14.9	Weight	8.9	11.8	12.0	14.6	14.5	
	74.7	81.6	85.9	92.9	...	Standing Height	72.8	80.3	85.9	92.1	...	
	45.0	48.0	49.1	51.8	...	Sitting Height	43.9	47.1	48.7	51.2	...	
Vellore	8.0	9.5	10.9	12.5	...	Weight	7.5	9.1	10.6	12.2	...	46
	44.3	46.0	46.9	47.4	...	Head Circumference	43.2	44.8	45.9	46.8	...	
	43.3	45.6	47.5	48.8	...	Chest ,,	42.3	44.6	46.7	48.0	...	
	12.2	12.4	13.0	13.3	...	Arm Circumference	11.7	12.1	12.9	13.3	...	

(to be contd.)

TABLE 17 (*Contd.*)

Place	MALES: Age in years					Measurements	FEMALES: Age in years					Reference No.
	1	2	3	4	5		1	2	3	4	5	
Vellore	15.1	16.2	17.3	18.2	...	Calf ,,	14.7	16.1	17.2	18.0	...	
	6.0	6.5	7.2	7.2	...	Fat fold at Triceps	6.0	6.7	7.4	7.4	...	
	9.5	9.4	9.4	8.9	...	Fat fold at Calf	9.1	9.6	9.4	7.4	...	
	71.9	82.1	87.7	93.8	...	Height	71.8	78.6	85.9	92.1	...	
	44.1	46.7	48.3	49.2	...	Sitting Height	43.1	45.8	47.4	47.9	...	
	8.2	9.5	10.0	13.0	...	Weight	7.8	9.3	10.5	12.5	...	
Bombay	45.5	46.3	48.5	48.9	...	Head Circumference	44.3	45.9	46.7	48.1	...	47
	46.0	46.9	49.2	50.4	...	Chest ,,	45.2	46.3	48.1	50.0	...	
	13.5	13.5	14.2	15.2	...	Arm ,,	13.2	14.3	14.0	14.4	...	
	15.4	16.2	17.8	19.7	...	Calf ,,	14.9	17.1	17.5	18.5	...	
	71.5	79.3	85.7	94.8	...	Standing Height	69.5	77.7	83.9	93.1	...	
	43.3	46.9	49.1	52.6	...	Sitting Height	42.0	45.8	49.7	51.8	...	
	8.1	10.1	11.6	13.7	...	Weight	7.3	9.4	10.9	13.1	...	
Delhi	44.7	46.5	47.6	48 5	...	Head Circumference	43.5	45.1	46.1	47.4	...	48
	43.0	46.2	48.3	50.1	...	Chest ,,	44.3	44.9	47.0	49.0	...	
	12.3	13.0	13.6	14.0	...	Arm ,,	11.9	12.8	13.2	13.9	...	
	14.9	16.6	17.5	18.6	...	Calf ,,	14.5	16.1	17.2	18.2	...	
	70.7	78.7	84.8	92.8	...	Standing Height	70.6	77.5	83.6	92.1	...	
Poona	43.2	46.8	49.2	52.3	...	Sitting Height	42.5	45.8	48.4	51.6	...	
	7.7	9.5	10.9	12.8	...	Weight	7.4	9.1	10.5	12.4	...	

Poona	43.6	45.2	46.3	47.1	...	Head Circumference	42.9	44.6	45.8	46.6	...	49
	42.8	45.7	48.0	49.3	...	Chest ,,	42.2	44.6	46.4	48.6	...	
	12.4	13.1	13.7	13.8	...	Arm ,,	12.3	13.0	13.4	14.1	...	
	14.8	16.3	17.1	17.9	...	Calf ,,	14.9	16.0	16.1	17.9	...	
Calcutta	72.2	80.2	87.9	96.6	...	Standing Height	71.2	78.9	86.8	95.9	...	50
	43.6	46.4	49.1	51.9	...	Sitting Height	42.4	45.4	48.5	51.2	...	
	8.5	10.1	11.9	13.7	...	Weight	8.1	9.4	11.2	13.3	...	
	44.3	46.1	47.0	47.7	...	Head Circumference	43.4	44.7	45.9	46.6	...	
	44.6	47.2	48.9	50.5	...	Chest ,,	43.6	45.7	47.7	48.8	...	
	12.6	13.4	13.3	13.9	...	Arm ,,	12.5	13.0	13.5	13.8	...	
	15.7	17.0	17.9	18.5	...	Calf ,,	15.3	16.3	17.7	18.4	...	
	6.5	6.9	7.1	6.6	...	Fat fold at Triceps	6.6	6.8	7.2	6.8	...	
	9.5	9.6	9.4	8.5	...	Fat fold at Calf	9.3	9.6	9.5	8.7	...	
Hyderabad	68.9	75.9	82.4	...	...	Standing Height	67.3	74.3	81.0	...	...	39
	43.2	45.7	49.0	...	...	Sitting Height	42.6	45.2	48.3	...	...	
	7.1	8.2	9.7	...	...	Weight	6.5	8.0	9.3	...	...	
	43.2	44.5	45.7	...	...	Head Circumference	42.2	44.0	45.3	...	...	
	41.1	43.4	46.2	...	...	Chest ,,	40.3	43.0	45.2	...	...	
Bihar	...	76.4	80.8	86.8	91.9	Height	...	74.4	79.8	84.6	89.9	51
	...	9.3	10.5	12.0	13.4	Weight	...	9.2	10.1	11.8	13.1	

TABLE 18

SKELETAL GROWTH OF PRE-SCHOOL CHILDREN

			Number of Centres Observed				
			1 Year	2 Years	3 Years	4 Years	5 Years
Carpal Centres (Total Centres 7)	*Indian:*						
		Boys	2.1	2.3	2.3	2.5	2.7
		Girls	2.1	2.4	2.6	3.0	3.3
	American:						
		Boys	2.0	2.0	4.0	5.0	5.0
		Girls	2.0	3.0	4.0	7.0	7.0
Epiphyseal Centres of long bones of fore-arm and hand (Total Centres 21)	*Indian:*						
		Boys	1.1	4.0	7.5	10.1	15.8
		Girls	4.3	11.8	15.3	17.4	19.6
	American:						
		Boys	0	8	19	20	21
		Girls	6	18	20	20	20

Number: Boys : 18
Girls : 34

Reference: Annual Report, Nutrition Research Laboratories (1964 – 65).

TABLE 19

A COMPARISON BETWEEN CHRONOLOGICAL AND SKELETAL AGE OF 284 INDIAN CHILDREN IN THE NILGIRIS

Economic Status	Number Examined	Chronological and skeletal ages agreeing as judged by American Standards	Skeletal age deviating from chronological age by years as judged by American Standards				
			1	2	3	4	5
Well-to-do	127	104 (81.9)	12 (9.4)	9 (7.1)	2 (1.6)	0	0
Poor	157	52 (33.0)	24 (15.3)	39 (25.0)	15 (9.5)	16 (10.0)	11 (7.0)

Figures in the parentheses indicate percentage.

Reference : Annual Report, Nutrition Research Laboratories (1953 – 54) p. 25.

TABLE

ANTHROPOMETRIC MEASUREMENTS OF CHILDREN

Place	Measurements	Age in 1	2	3	4	5	6	7
								MALES
Hyderabad	Height	...	...	96.9	103.8	112.1	116.4	123.1
	Weight	...	...	14.2	16.2	18.3	20.5	22.7
	Arm Circumference	...	...	15.2	16.0	15.9	16.7	16.9
	Fat Fold at Triceps	...	...	7.5	7.9	6.7	7.6	7.7
	Bicristal Diameter	...	...	16.1	16.7	17.7	18.3	19.1
Bombay	Height	84.7	91.7	97.9	105.5	111.8	...	123.0
	Weight	12.6	14.3	14.2	16.5	17.5	...	23.0
	Head Circumference	48.2	50.3	49.3	50.0	50.5	...	52.1
	Chest Circumference	50.2	53.3	50.9	52.4	52.5	...	59.3
Calcutta	Height	...	...	...	...	107.1	116.5	121.9
	Weight	...	...	...	...	17.3	20.6	23.3
								FEMALES
Hyderabad	Height	...	...	94.8	101.7	107.7	113.2	118.9
	Weight	...	...	13.5	15.1	16.5	18.0	20.0
	Arm Circumference	...	...	15.2	15.5	16.6	15.8	16.3
	Fat Fold at Triceps	...	...	8.8	8.4	7.7	7.6	7.8
	Bicristal Diameter	...	...	16.6	16.3	16.9	17.5	18.4
Bombay	Height	76.8	90.8	97.4	105.6	112.3	116.8	122.5
	Weight	9.2	...	13.7	17.4	18.7	21.2	24.1
	Head Circumference	45.0	46.3	49.6	49.8	50.9	...	51.1
	Chest Circumference	44.4	52.1	49.5	53.1	55.1	59.2	54.0

BELONGING TO HIGH INCOME GROUP

YEARS										Reference No.
8	9	10	11	12	13	14	15	16	17	
127.8	132.2	136.8	943.5	147.3	154.0	158.3	164.1	167.7	173.9	
24.3	27.2	28.6	32.9	35.1	40.3	44.9	49.5	53.6	56.9	
17.2	18.1	18.1	19.1	19.7	21.0	22.0	22.9	23.7	24.1	52
7.2	7.7	7.6	8.7	8.4	8.8	8.6	8.0	8.5	8.0	
19.6	20.2	21.0	22.0	22.4	23.5	24.0	24.8	25.3	26.4	
133.1	...	...	...	149.9	...	...	...	...	...	
26.6	...	...	...	41.5	...	...	...	...	...	3 8
51.6	...	...	...	52.9	...	...	...	...	...	
61.1	...	...	...	73.7	...	...	...	...	...	
127.4	131.9	136.1	141.5	146.7	155.4	161.9	165.9	166.9	...	53
24.9	26.7	28.8	33.1	35.8	42.8	48.3	51.7	53.1	...	
124.2	129.6	135.2	141.2	146.9	150.4	152.8	153.8	155.1	154.3	
22.0	24.5	27.5	31.3	35.3	38.0	41.4	42.5	42.9	43.7	
16.7	17.3	17.9	18.7	19.5	20.1	21.0	21.3	21.2	21.5	52
8.0	8.4	8.7	8.9	9.5	10.2	11.1	11.7	11.4	11.9	
19.1	19.9	20.9	22.1	23.3	24.2	25.3	25.6	25.8	25.9	
130.0	...	136.2	145.8	154.8	...	...	...	...	...	
26.8	...	28.5	35.2	42.7	...	...	...	...	...	38
51.7	...	52.3	52.3	54.3	...	...	...	...	...	
63.5	...	63.0	67.2	71.6	...	...	...	...	...	

TABLE

ANTHROPOMETRIC MEASUREMENTS

MALES

Place	Measurements	Age in 6	7	8	9	10
All India	Standing Height	108.5	113.9	119.3	123.7	128.4
	Sitting Height	59.4	61.7	63.8	65.6	67.5
	Weight	16.3	18.0	19.7	21.5	23.5
	Bicristal Diameter	17.2	17.9	18.5	19.1	19.8
	Head Circumference	49.0	49.4	49.9	50.1	50.4
	Chest ,,	52.5	54.2	55.5	57.3	59.1
Nilgiris	Height	102.9	108.4	113.3	115.3	122.7
	Weight	15.0	16.4	18.0	18.8	21.3
	Hip Width	16.1	16.8	17.9	17.9	18.6
	Skin Fold at Biceps	4.6	4.5	4.4	4.1	4.2
	Skin Fold at Triceps	7.9	8.1	7.8	7.4	7.8
Bombay						
Marathi	Height	106.2	111.2	115.6	120.1	124.5
	Weight	15.4	16.7	18.0	19.5	21.1
	Chest Circumference	51.0	52.1	53.1	54.1	55.4
Gujarati	Height	107.7	112.8	117.8	123.2	128.0
	Weight	15.5	17.3	19.0	20.9	22.9
	Chest Circumference	50.8	52.3	53.8	55.4	56.1
South Indian	Height	106.7	112.8	117.8	123.4	127.0
	Weight	15.7	17.4	18.9	21.1	22.8
	Chest Circumference	53.1	54.1	55.4	56.4	57.6
Maharastra	Height	104.0	109.0	113.0	119.5	123.7
	Weight	15.5	17.1	19.5	21.5	22.2
	Head Circumference	50.2	51.0	51.7	52.3	52.6
	Chest Circumference	53.6	54.4	55.9	57.2	58.4
Bombay	Height	106.6	112.1	116.8	122.1	127.4
	Weight	15.6	17.0	18.5	20.5	22.7
	Head Circumference	50.3	50.6	50.8	51.2	51.1
	Chest Circumference	53.3	54.7	56.7	57.7	59.2

OF SCHOOL CHILDREN

YEARS									Reference No.
11	12	13	14	15	16	17	18	19	
133.4	138.3	144.6	150.1	155.5	159.5	161.4	163.1	163.5	
69.5	71.4	74.2	76.8	79.8	82.0	83.7	84.4	84.8	
25.9	28.5	32.1	35.7	39.6	43.2	45.7	47.4	48.1	40
20.4	21.1	22.1	23.0	24.0	24.7	25.2	25.4	25.5	
50.7	51.1	51.6	52.0	52.6	53.0	53.3	53.5	53.5	
60.4	62.9	65.4	67.8	70.9	73.2	75.5	76.5	77.3	
127.2	130.0	135.6	140.5	147.3	153.2	155.9	160.5	160.5	
23.1	24.5	27.2	30.3	34.9	39.4	42.5	44.8	45.2	
19.0	19.6	20.3	21.3	22.4	23.6	24.6	25.1	25.0	43
4.3	4.2	4.2	3.6	3.8	...	...	...	...	
8.0	8.0	7.9	7.3	7.6	...	...	...	...	
129.3	133.8	139.2	145.8	152.4	158.0	162.6	...	...	
23.1	25.4	27.3	31.8	35.9	40.9	44.7	...	...	
56.6	57.9	59.2	62.0	64.8	67.8	69.8	...	...	
132.3	137.4	142.7	148.8	153.9	158.0	161.5	...	...	
25.0	27.8	31.1	34.9	38.9	42.1	45.0	...	...	54
57.4	58.7	61.0	63.2	66.3	68.3	70.9	...	...	
132.3	136.9	143.2	148.6	154.2	157.5	160.0	...	...	
25.2	26.8	30.6	33.9	38.5	40.8	43.5	...	...	
58 8	59.9	62.0	64.0	65.8	67.6	69.3	...	...	
127.5	132.0	142.2	145.4	157.0	159.0	...	...	...	
23.5	26.1	27.5	30.2	34.5	39.5	...	...	...	55
53.0	53.3	53.9	54.6	55.0	55.1	...	...	...	
60.5	62.5	64.5	66.5	68.6	73.2	...	...	...	
133.6	135.9	...	...	...	...	...	...	...	
25.1	25.5	...	...	...	...	...	...	...	38
51.9	51.5	...	...	...	...	...	...	...	
61.2	62.4	...	...	...	...	...	...	...	

(to be contd.)

TABLE

MALES

Place	Measurements	Age in 6	7	8	9	10
Lucknow	Height			115.9	120.8	124.3
	Weight			19.3	20.7	22.4
Hyderabad	Height	105.4	112.2	116.5	121.8	127.0
	Weight	15.2	16.9	18.4	20.3	22.3
	Arm Circumference	14.9	15.0	15.6	16.0	16.5
	Fat Fold at Triceps	6.2	5.9	5.7	5.9	5.9
Ahmedabad	Height	107.4	112.3	116.3	121.2	125.7
	Weight	15.7	17.0	18.3	19.8	21.6
Ankola	Height	109.1	114.7	119.8	123.8	127.2
	Weight	15.8	18.0	19.6	21.7	22.4
Madras State	Height	105.9	109.5	116.3	121.4	126.0
	Weight	16.5	17.4	19.7	21.9	22.1
Madras						
Urban	Height	106.9	112.3	116.3	121.7	125.7
	Weight	16.2	17.1	18.8	21.3	22.8
Rural	Height	105.4	108.7	113.5	119.1	123.2
	Weight	14.8	15.5	17.1	18.5	20.6
Bihar	Height	98.0	101.6	107.7	114.0	119.6
	Weight	14.9	16.2	17.9	19.8	21.8
Uttar Pradesh	Height	116.1	122.2	126.7	128.5	133.6
	Weight	19.5	20.7	22.3	23.2	26.2

21 (*Contd.*)

YEARS									Reference No.
11	12	13	14	15	16	17	18	19	
129.3	134.7	135.5	137.9	141.7	...	...	...	...	56
24.0	26.1	26.7	28.5	30.8	...	...	...	...	
130.0	135.1	139.7	144.0	153.0	156.3	158.5	...	...	
23.8	26.0	28.7	30.6	37.3	40.0	43.7	...	...	57
16.9	17.4	18.2	18.4	20.3	21.1	22.5	...	...	
5.3	6.2	6.5	6.0	6.3	5.9	6.1	...	...	
131.1	134.6	139.7	144.8	150.6	155.9	159.2	...	...	58
24.0	25.7	28.5	31.5	35.1	39.0	41.5	...	...	
133.1	137.3	142.9	151.0	...	...	...	...	...	10
26.0	28.5	32.0	35.9	...	...	...	...	...	
130.5	133.8	138.9	143.8	150.9	152.9	155.4	157.5	161.5	45
24.8	27.6	29.1	31.3	37.8	39.1	42.3	44.4	45.1	
132.3	136.4	141.7	145.5	149.6	...	...	...	...	59
25.3	27.0	29.4	32.4	35.4	...	...	...	...	
129.8	129.8	135.9	141.0	141.7	...	...	...	...	
22.2	23.7	25.5	29.1	29.1	...	...	...	...	
124.5	131.1	137.9	143.8	148.6	...	...	...	...	51
24.1	26.8	30.0	34.0	40.0	...	...	...	...	
136.6	141.2	147.8	150.9	156.7	160.3	160.3	161.5	167.6	60
26.5	29.0	33.6	36.1	39.0	42.2	43.8	45.6	47.7	

TABLE

ANTHROPOMETRIC MEASUREMENTS

FEMALES

Place	Measurements	Age in 6	7	8	9	10
All India	Standing Height	107.4	112.8	118.2	122.9	128.4
	Sitting Height	58.4	60.7	62.9	64.8	67.1
	Weight	16.0	17.6	19.4	21.3	23.6
	Bicristal Diameter	17.0	17.8	18.4	19.1	19.9
	Head Circumference	48.3	48.9	49.3	49.7	50.1
	Chest Circumference	51.3	52.9	54.7	56.2	58.4
Nilgiris	Height	101.8	106.9	112.3	117.6	121.4
	Weight	14.4	15.5	17.2	19.0	20.7
	Hip Width	16.0	16.6	16.7	17.8	18.5
	Fat Fold at Biceps	5.6	4.7	4.5	4.2	4.7
	Fat Fold at Triceps	8.2	8.4	8.0	7.8	8.4
Bombay						
Marathi	Height	104.6	109.0	114.0	118.9	124.7
	Weight	14.8	16.0	17.6	19.0	21.2
	Chest Circumference	50.3	51.3	52.6	53.6	55.1
Gujarati	Height	105.1	110.0	115.1	121.4	127.0
	Weight	15.1	16.6	18.6	21.0	23.3
	Chest Circumference	52.3	52.6	53.6	55.4	56.4
South Indian	Height	110.2	113.8	118.9	123.4	130.0
	Weight	15.4	17.2	19.4	21.7	24.4
	Chest Circumference	55.1	56.1	57.4	58.4	59.7
Maharastra	Height	104.0	107.8	111.8	117.0	123.2
	Weight	12.8	15.9	16.1	19.0	20.9
	Head Circumference	49.6	50.1	50.9	51.4	51.7
	Chest Circumference	51.0	52.3	53.3	53.8	54.2
Bombay	Height	107.0	111.8	117.4	125.1	131.6
	Weight	15.4	17.1	18.3	22.1	24.5
	Head Circumference	49.0	50.2	49.9	50.8	51.1
	Chest Circumference	52.7	54.7	57.5	58.5	59.8

OF SCHOOL CHILDREN

YEARS									Reference No.
11	12	13	14	15	16	17	18	19	
133.6	139.2	143.9	147.5	149.6	151.0	151.5	151.7	151.7	
69.5	72.2	74.6	76.8	77.9	78.8	79.2	79.2	79.2	
26.4	29.8	33.3	36.8	36.8	41.1	42.4	42.4	42.4	40
20.9	22.0	23.1	24.1	24.8	25.2	25.5	25.5	25.5	
50.6	51.0	51.6	52.0	52.2	52.4	52.5	52.5	52.5	
60.7	63.4	66.9	70.2	71.5	72.9	73.1	73.8	74.1	
123.9	128.0	135.4	140.7	...	...	...	...	...	
22.2	24.3	28.7	33.5	...	...	...	...	...	
18.3	18.6	...	...	...	...	...	...	...	43
4.9	4.2	4.8	...	...	...	...	...	...	
8.2	8.1	8.1	...	...	...	...	...	...	
130.3	135.1	140.5	144.0	147.6	148.6	149.6	...	...	
23.5	25.9	29.1	32.3	35.9	38.2	40.4	...	...	
57.1	59.2	62.0	64.8	66.8	67.8	68.3	...	...	
133.1	138.2	144.5	149.9	152.6	154.2	155.7	...	...	
26.5	29.1	34.1	37.7	39.5	41.2	41.8	...	...	54
58.4	60.2	62.0	64.0	65.3	66.8	66.0	...	...	
135.1	140.2	144.0	147.8	149.9	150.9	151.1	...	...	
26.8	29.2	33.6	37.2	39.5	40.0	39.8	...	...	
60.4	62.5	65.8	68.1	69.1	69.8	69.8	...	...	
125.3	129.7	135.9	142.0	147.0	153.4	...	...	...	
22.8	26.5	29.2	30.5	34.5	37.9	...	...	...	55
52.3	52.3	52.6	53.1	53.4	53.8	...	...	...	
56.4	57.6	58.4	59.9	63.0	66.3	...	...	...	
135.7	141.1	...	...	...	...	...	...	...	
26.0	30.4	...	...	...	...	...	...	...	38
51.2	52.0	...	...	...	...	...	...	...	
61.9	65.8	...	...	...	...	...	...	...	

(to be contd.)

TABLE

FEMALES

Place	Measurements	Age in 6	7	8	9	10
Lucknow	Height	...	...	114.9	117.3	122.1
	Weight	...	...	18.3	19.5	20.8
Hyderabad	Height	102.3	109.2	116.3	121.5	128.3
	Weight	14.2	16.2	18.1	20.3	23.3
	Arm Circumference	14.8	15.4	15.7	16.5	17.1
	Fat Fold at Triceps	6.9	6.9	6.5	7.3	7.1
Ahmedabad	Height	105.1	110.2	115.1	120.1	124.2
	Weight	15.4	16.5	18.1	19.6	20.9
Ankola	Height	106.6	113.3	121.8	124.1	125.1
	Weight	15.9	17.7	20.1	21.7	23.3
Madras State	Height	108.2	112.3	120.4	121.7	126.2
	Weight	15.6	17.9	19.1	20.3	23.0
Madras						
Urban	Height	106.7	111.0	119.4	120.9	125.0
	Weight	16.7	17.1	20.0	21.4	23.0
Rural	Height	104.6	108.4	113.5	119.1	123.4
	Weight	14.3	15.6	17.1	19.0	20.8
Bihar	Height	94.2	99.3	104.9	110.5	116.1
	Weight	13.9	15.5	17.2	19.0	20.9

22 *(Contd.)*

YEARS									Reference No.
11	12	13	14	15	16	17	18	19	
126.0	132.9	133.0	128.0	...	...	...	...	...	56
21.6	26.5	26.0	25.0	...	...	...	...	...	
131.4	136.9	142.9	146.8	148.0	149.1	154.7	...	...	
24.7	28.4	31.8	36.0	37.1	38.9	40.9	...	...	57
17.4	18.2	19.1	20.3	20.6	21.1	20.8	...	...	
7.4	7.7	8.2	9.6	10.5	10.2	8.6	...	...	
129.5	134.6	139.7	144.3	147.3	149.3	150.9	...	...	58
23.2	26.0	29.5	32.8	35.2	37.7	39.1	...	...	
134.5	139.2	144.6	148.1	...	...	...	...	...	10
28.9	30.8	33.7	36.5	...	...	...	...	...	
131.6	134.9	135.4	143.2	145.5	146.5	148.1	149.3	151.1	45
25.1	28.4	28.6	34.5	38.3	40.2	41.3	42.7	42.7	
132.6	135.6	141.0	...	...	...	...	...	...	
25.9	28.0	31.1	...	...	...	...	...	...	59
127.5	132.1	136.6	...	...	...	...	...	...	
22.5	24.8	25.6	...	...	...	...	...	...	
121.9	127.5	134.1	140.2	...	...	...	...	...	51
24.1	27.3	29.8	33.9	...	...	...	...	...	

TABLE 23

PERCENTAGE PREVALENCE OF NUTRITIONAL DEFICIENCY SIGNS IN RURAL PRE-SCHOOL CHILDREN

Deficiency Signs	Age in Years			
	1 – 2	2 – 3	3 – 4	4 – 5
Conjunctival Xerosis	1.2	7.9	12.0	16.3
Bitot's Spots	0.8	3.5	7.7	7.5
Keratomalacia	0.3	...	0.7	0.7
Night Blindness	...	1.4	0.9	1.3
Angular Stomatitis	5.8	15.8	23.0	28.5
Glossitis	1.8	2.9	7.0	10.0
Oedema	1.5	2.7	2.1	0.9
Moonface	2.8	9.1	4.1	1.9

Reference : Swaminathan, M. C., Susheela T. P. and Thimmayamma, B. V. S. (December, 1969) *Amer. J. Clin. Nutr.*

TABLE 24

PERCENTAGE PREVALENCE OF NUTRITIONAL DEFICIENCY SIGNS IN PRE-SCHOOL CHILDREN

	Hyderabad	Vellore	Poona	Delhi	Bombay	Calcutta
Hair :						
Sparse	4.3	0.5	3.5	1.0	11.7	2.1
Discolouration	7.0	13.8	5.9	1.6	0.9	2.6
Easily Plucked	1.1	2.0	4.0	...	0.0	0.2
Moon face	4 2	2.5	7.2	3.4	0.7	0.1
Oedema	0.5	0.4	2.8	0.9	0.4	0.2
Marasmus	1.1	1.4	1.7	1.7	0.0	2.1
Corneal Xerosis	0.0	0.1	0.4	0.2	0.0	0.0
Conjunctival Xerosis	6.5	0.7	15.6	0.7	1.2	1.2
Bitot's Spots	3.9	4.8	6.3	1.0	2.0	0.7
Angular Stomatitis	6.2	14.5	3.2	1.7	2.1	3.0
Rickets	0.1	1.2	2.2	0.2	0.2	0.5
Caries	1.0	3.3	7.4	0.8	18.9	9.0

Source : Studies on Pre-school Children conducted under the auspices of Indian Council of Medical Research.

TABLE

PERCENTAGE PREVALENCE OF NUTRITIONAL DEFICIENCY SIGNS

Signs	0 – 5 Years						
	Madras			Andhra Pradesh		Mysore	
	Poona-malle	Tiruchi-rapalli	Madurai	Hydera-bad	Guntur	Ramana-garam	Alur
Crazy Pavement Dermatosis	0.3	0.0	0.0	0.0	0.0	0.0	0.4
Hair :							
Sparse	6.0	7.0	2.3	1.0	3.0	3.1	1.5
Discoloured	15.4	8.1	1.7	24.6	24.9	14.3	9.0
Hepatomegaly	1.3	1.5	18.0	9.6	3.0	1.6	7.1
Moonface	3.3	5.2	1.4	12.0	6.0	1.0	4.4
Kwashiorkor	0.3	0.4	...	1.0	1.0	1.4	1.4
Xerosis of Conjunctiva and Bitot's Spots	7.0	3.5	1.7	3.4	7.0	0.2	1.0
Angular Stomatitis	4.0	3.8	4.0	2.6	3.6	0.6	0.6
Night Blindness	...	...	...	...	...	...	...
Protein–Calorie Malnutrition	...	...	...	...	...	...	...
Severe Anaemia	...	...	...	...	...	...	...
Oedema	...	...	...	...	...	...	...
Bleeding gums	...	...	...	...	...	...	...
Glossitis	...	...	...	...	...	...	...
Phrynodema	...	...	...	...	...	...	...
Reference :	1						

1. Someswara Rao, K., Swaminathan, M. C., Swarup, S. and Patwardhan, V. N. (1959) *Bull. wld. Hlth. org.* **20**: 603.

2. Jyothi, K. K., Dakshayani, R., Swaminathan, M. C. and Venkatachalam, P. S. (1963) *Trop. geogr. Med.* **15**: 403.

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PRE-SCHOOL CHILDREN

Kerala		Andhra Pradesh	Mysore	Nilgiris			
				(Age in years)			
Trivandrum	Malabar	Hyderabad	Ankola	2	3	4	5
0.2	0.3	...	...	...	...	...	...
8.4	...	...	2.1	...	...	...	...
6.0	0.9	...	4.5	...	...	...	...
3.1	6.7	...	1.1	...	...	...	...
3.0	4.0	3.2	1.3	...	...	1.3	1.0
1.5	0.4	...	...	13.0	4.6	3.9	1.0
0.5	0.5	4.5	11.0	8.7	12.3	21.8	14.1
2.9	3.2	9.0	3.4	4.4	4.6	3.9	3.0
...	...	2.6	...	4.4	1.5	6.4	7.1
...	...	1.0	...	...	...	...	...
...	...	0.3	...	...	...	...	...
...	...	...	0.1	...	...	...	...
...	...	...	...	...	1.5	...	...
...	...	...	...	4.4	4.6	3.9	3.0
...	...	...	...	...	...	3.9	2.0
		2	3	4			

3. Swaminathan, M. C., Apte, S. V. and Someswara Rao, K. (1960) *Ind. J. Med. Res.* **48** : 762.

4. Someswara Rao, K., Tasker, A. D. and Ramanathan, M. K. (1954) *Ind. J. Med. Res.* **42** : 55.

TABLE

MEAN HAEMOGLOBIN LEVELS (g%) IN

Age	Hyderabad		Vellore		Calcutta		Poona		Delhi		Bombay	
	M	F	M	F	M	F	M	F	M	F	M	F
0–1 Year	...	...	...	...	...	...	...	...	...	...	...	...
1–2 Years	9.9	9.9	10.3	10.5	10.4	10.7	9.8	10.7	8.6	8.7	9.9	10.0
2–3 ,,	10.0	9.9	10.6	10.7	11.1	11.0	10.3	10.3	8.5	9.0	10.5	10.3
3–4 ,,	10.1	10.2	11.3	11.0	11.5	11.4	11.5	11.7	8.5	8.7	10.9	10.5
4–5 ,,	11.3	10.9	11.6	11.6	12.0	11.8	12.0	11.8	10.0	9.4	11.5	11.2
1–5 ,,	10.3	10.3	11.0	10.9	11.3	11.3	10.9	11.1	9.0	8.9	10.7	10.5
5–6 ,,	...	...	...	...	...	...	...	...	...	...	...	...
Reference	42		46		50		49		48		47	

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INFANTS AND PRE-SCHOOL CHILDREN

Madras		Andhra Pradesh		Mysore		Kerala		Nilgiris		Nilgiris	
Trichi	Madurai	Hyderabad	Guntur	Ramnagar	Alur	Trivandrum	Malabar	M	F	M	F
10.3	11.7	8.3	10.9	9.7	10.6	11.9	9.6	...	...	...	...
9.7	11.4	7.7	10.6	9.7	10.6	11.2	10.0	...	...	...	...
9.6	11.1	8.1	11.1	10.2	11.4	11.7	10.1	12.3	12.5	11.1	10.1
10.00	12.2	9.1	10.1	10.4	11.5	11.8	10.5	12.3	11.7	12.2	11.1
10.4	11.3	8.9	10.7	10.9	12.2	12.1	10.3	11.7	11.7	11.2	11.5
...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	12.3	11.9	12.1	11.7
61								43		62	

TABLE

MEAN HAEMOGLOBIN LEVELS (g/100 ml)

Age (Years)	Bombay					
	Males		Females		Males	Females
	Marathi	Gujarati	Marathi	Gujarati	S. Indian	
6	11.5	11.6	11.8	11.5	15.5	12.0
7	11.7	11.9	11.9	11.6	12.7	13.7
8	11.9	12.0	12.1	11.9	13.0	13.4
9	11.9	12.4	12.2	12.0	13.5	13.4
10	12.1	12.4	12.2	12.3	13.6	13.3
11	12 2	12.4	12.1	12.7	13.6	13 7
12	12.6	12.7	12.3	13.0	13.5	13.3
13	12.8	12.9	12.4	13.2	...	...
14	13.1	13.2	12.7	12.9	...	...
15	13.4	13.3	12.7	12.6	...	...
16	13.9	13.6	12.8	12.3	...	...
17	14.6	13.9	12.3	12.1	...	...
18	...	...	...	...	...	...
19	...	...	...	...	...	...
Reference No.	54					

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IN SCHOOL CHILDREN

Nilgiris		Uttar Pradesh	Nilgiris		Ankola	
Males	Females	Males	Males	Females	Males	Females
12.8	12.2	13.9	12.5	11.9		
12.6	12.4	13.8	12.3	12.2	11.3	10.9
12.6	12.5	13.8	12.3	12.4	(Children under 15 Years of age)	
12.7	12.7	13.9	12.7	12.8		
13.0	12.8	14.1	12.7	12.5		
13.2	12.6	14.0	12.8	12.0		
12.9	13.2	14.0	12.7	12 5		
12.9	12.5	14.4	12.8	12.3		
12.9	...	14.3	12.8	11.0		
13.3	...	14.9	13.2	...		
13.4	...	14.7	13.3	...		
14.0	...	15.1	14.0	...		
14.5	...	15.1	14.6	...		
14.5	...	15.0	14.5	...		
43			62		10	

TABLE 28

MEAN HAEMOGLOBIN (g%) LEVELS IN ADULTS

Source	Place	Males	Females	Reference
Banerjee	Assam :			
	Adults (18–24 Yrs.)	14.4	12.8	
	Officers	15.1	...	1
	Skilled labourers	14.2	...	
	Indian Soldiers	15.9	...	
Rammurthi		17.0	...	2
Ganguli		...	11.8	3
Man Mohan Singh *et al*	Punjab	...	13.1	4
Swaminathan *et al*	Mysore	13.5	11.3	5
Rao *et al*	Madras	12.6	10.7	6

1. Banerjee, B. (1958) *J. Ind. Med. Assn.* **31 :** 67.
2. Rammurthi, K. (1955) *Ind. J. Med. Res.* **43 :** 57.
3. Ganguli, N. C. (1954) *J. Ind. Med. Assn.* **23 :** 332.
4. Man Mohan Singh, Kapoor, S. P. and Gurbachan Singh (1953) *Ind. Med. Gazette*, **88 :** 316.
5. Swaminathan, M. C., Apte, S. V. and Someswara Rao, K. (1960) *Ind. J. Med. Res.* **48 :** 762.
6. Rao, B. R. H., Kloutz, C. E., Benjamin, V., Rao, P. S. S., Almas Begum. and Dumm, M. E. (1960) *J. Ind. Med. Assn.* **35 :** 259.

TABLE 29

INCIDENCE OF FLUOROSIS

Place	Dental Fluorosis					Skeletal Fluorosis	Reference No.
	Age Group	Overall	Grade I	Grade II	Grade III		
Mansa Tehsil (Punjab)	School Children	67%	...	...	...	...	
Sangrur District (Punjab)	0–5	...	80	2.5	17.5	...	63
	6–10	...	18	18	64	...	
	11–20	...	5.4	19.6	75	...	
	21–30	...	28.9	39.5	31.6	...	
	31–40	...	44.5	33.3	22.2	...	
	41–50	...	12.5	50.0	37.5	...	
	51–60	...	16.7	25.0	58.3	...	
	61–70	...	100				
Cuddapah District (Andhra Pradesh)	School Children	60%	...	...	...	...	
Tadpatri Taluk Anantapur District (Andhra Pradesh)	School Children	100%	...	...	...	...	
Pattikonda Taluk Kurnool District (Andhra Pradesh)	School Children	100%	...	...	...	...	64
Podili Nellore District (Andhra Pradesh)	...	74%	23	20	31	...	
	Girls	75.2	...	...	27.9	...	
	Boys	74.2	...	...	34.3	...	
	Men	...	...	...	...	75.2	
	Women	...	...	...	...	73.6	
Bhatinda District (Punjab)	...	23.6	...	...	...	...	65
	School Children	67	40	25	2	...	

TABLE 30

HOSPITAL AND DISPENSARY RETURNS OF CASES TREATED FOR GOITRE (1947 - 49)

Region	1947	1948	1949
Ajmeer-Merawa	...	3	3
Assam	27,403	24,183	33,999
Bihar	25,799	...	...
Bombay	571	696	926
Madhya Pradesh	165	616	...
Madras	1,952	7,965	8,258
Orissa	31	215	...
Punjab	14,860	11,159	10,508
Uttar Pradesh	44,512	39,678	44,723
West Bengal	7,799	7,663	8,295
Total	123,092	92,178	106,712

Reference: Ramalinga Swamy, V. (1953) *Bull. wld. Hlth. org.* **9**: 275.

TABLE 31

INCIDENCE OF GOITRE

Region		Percentage	Number	Year
Kashmir - Karkoram		90	...	1945
Uttar Pradesh	Dehra Dun	32	554	1945
	Bareiley	26	133	1947
Bihar	Purnia Dt.	50	3 Villages	1952
	Ranchi Dt.	70	563	1952
East Punjab	Shiwalall	32	5042	1952
	Range	37	1337	1952
West Bengal	Darjiling	67	8204	1953

Reference : As cited by Ramalinga Swamy, V. (1953) *Bull. Wld. Hlth. Org.* **9** : 275.

TABLE 32

DEAF MUTE RATES IN GOITROUS REGIONS

State	Region	Per 100,000
Punjab	Himalyan Division	257
	Provincial Average	89
Bihar	Champaram Dt.	169
	Provincial Average	72
Assam	Naga Hills	490
	Provincial Average	70

Reference : Patwardhan, V. N. (1961), Nutrition in India, The *Ind. J. Med. Sci.*, Bombay.

TABLE 33

INCIDENCE OF GOITRE BY STATUS OF GOITRE

Locality *	Age group	Sex	No.	Status of Goitre				Asymmetrical and/or nodular
				Diffuse Smooth & Symmetrical				
				—	+	++	+++	
Area I	12–16	M	15	...	5	8	1	1
	12–16	F	18	...	9	7	2	...
Area II	8–12	M	30	...	4	6	4	16
	8–12	F	13	...	5	3	1	4
Area III	12–14	M	9	9	...	...	...	...
	14–15	F	9	9	...	...	...	...

\+ Just Visible, diffuse and Symmetrical

++ Clearly Visible, diffuse and Sommetrical.

+++ Very clearly visible diffuse and Symmetrical.

— Absence of visible goitre.

*Area I (Endemic) – Pathank Dt. – Punjab with a prevalence rate of 50%.

Area II (Endemic) – Bettea – Bihar with a prevalence rate of 100%.

Area III Non–endemic in Bihar.

Reference: Ramalinga Swamy, V., Subramaniam, T. A. V. and Deo, M. G. (1961) *Lancet* **i**: 791.

TABLE 34

EFFECT OF IODISATION OF SALT ON THE INCIDENCE OF GOITRE

Zones	1956 Survey : Before Iodisation				1962 Survey : after Iodisation		
	Sex	Number Examined	Number with Goitre	Prevalence % of Goitre	Number Examined	Number with Goitre	Prevalence % of Goitre
General Population							
A	Males	2023	532	26.3	1414	165	11.5
	Females	2377	1334	56.1	1876	429	22.9
B	Males	5446	892	36.5	1775	663	35.3
	Females	2630	1494	56.8	2271	1217	53.6
C	Males	1942	555	28.6	1223	149	12.2
	Females	2209	1116	50.5	1598	324	20.3
School Children							
A	...	2529	951	37.6	3495	666	19.1
B	...	2027	767	37.8	4544	1829	40.3
C	...	2964	1138	38.4	3420	500	14.6
Total	...	7520	2856	38.0	11.459	2995	26.1

Zone A : Salt fortified with Potassium Iodide (KI)

Zone B : Control Zone

Zone C : Salt Fortified with Potassium Iodate (KIO_3)

Reference : Sooch, S. S. and Ramalinga swami, V. (1965) *Bull. Wld. Hlth. Org.* **32 :** 299.

TABLE 35

INCIDENCE OF LATHYRISM IN REWA (Dt.) OF MADHYA PRADESH

Age Group	Rewa District – Madhya Pradesh			
	Established Cases		Latent Lathyrism	
	Males	Females	Males	Females
0–5	0.4	...	1.8	0.6
6–10	2.8	1.1	2.2	1.6
11–15	3.4	0.9	2.7	2.3
16–25	5.6	0.4	1.9	0.8
26–35	5.3	...	3.5	2.1
36–45	2.5	...	3.5	2.8
46–55	2.6	0.5	4.4	2.0
$\geq$ 56	0.5	0.6	1.1	2.0
Total	3.2	10.3	2.6	1.7

Reference : Ganapathi, K. T. and Dwivedi, M. P. (1961) '*Studies on clinical epidermiology of Lathyrism*' — Lathyrism enquiry field unit, Indian Council of Medical Research, Rewa (M. P.)

TABLE 36

EFFECT OF AN ANNUAL MASSIVE SINGLE ORAL DOSE OF VITAMIN A (100,000μg) ON THE INCIDENCE OF VITAMIN A DEFICIENCY SIGNS (%PREVALENCE)

Age group in years	Conjunctival Xerosis		Bitot's Spots	
	Initial	After one dose	Initial	After one dose
2 – 3	15.9	1.0	7.3	1.0
3 – 4	14.9	1.9	9.1	0.6
4 – 5	15.0	3.5	9.1	0.9
5 – 6	15.5	3.2	9.5	1.9

Reference : Annual Report, Nutrition Research Laboratories (1966 – 67)

TABLE 37

EFFECT OF FEEDING GREEN LEAFY VEGETABLES ON SERUM VITAMIN A *

Initial level of serum Vitamin A μg %	Number of children		Initial Values of serum Vitamin A μg %		Final Values of serum Vitamin A μg %		Differences between initial and final values of serum Vitamin A	
	Experimental	Controls	Experimental	Controls	Experimental	Controls	Experimental	Controls
< 25	17	3	15.4 ± 1.41	17.5 ± 3.04	28.0 ± 2.26	17.9 ± 1.33	12.6 ± 1.83 (P < 0.001)	0.3 ± 2.63 (N. S.)
> 25	12	3	31.2 ± 1.98	31.8 ± 1.28	37.5 ± 4.47	27.0 ± 1.90	6.2 ± 4.27 (N. S.)	−4.8 ± 1.72 (N. S.)
All Children	29	6	21.9 ± 1.83	24.7 ± 3.51	31.9 ± 2.39	22.5 ± 2.31	10.0 ± 2.11 (P < 0.001)	−2.2 ± 1.82 (N. S.)

* 40 g of Amaranth providing 1200 μg β-carotene fed daily for 15 days.

Reference: Vinod R. Lala and Vinodini Reddy (December, 1969) *Amer. J. Cli. Nutr.*

TABLE 38

PERCENTAGE INCIDENCE OF NUTRITIONAL DEFICIENCY SIGNS BY BIRTH ORDER IN PRE-SCHOOL CHILDREN OF RURAL AREAS AROUND HYDERABAD CITY

Birth Orders	Sample covered	With Any Nutritional Deficiency signs	Moon Face	Marasmus or Kwashiorkor	Discolouration of Hair	Protein Calorie Malnutrition	Angular Stomatitis	Vitamin A Deficiency
I 1–3	900	17.0***	3.8**	0.8**	6.0***	4.4***	5.5	6.7***
II 4 and above	570	32.0	8.0	2.8	10.5	11.0	7.0	12.6

** $P < 0.01$
*** $P < 0.001$

Source: Gopalan, C. (1968) *J. Trop. Paediatrics*, **14**: 228.

TABLE 39

MENTAL PERFORMANCE OF CHILDREN WHO HAD RECOVERED FROM KWASHIORKOR EXPRESSED AS PERCENTAGE OF MATCHED CONTROL SUBJECTS

Age Years	Number	Mean	Median
8– 9	11	31.30	26.83
9–10	5	54.45	54.77
10–11	3	52.44	52.33

Source : Champakam, S., Srikantia, S. G. and Gopalan, C., (1968) *Amer. J. Clin. Nutr.* **21** : 844.

TABLE 40

ANTHROPOMETRIC MEASUREMENTS – NEFA AREA BY AGE AND SEX

Age (years)	MALES Height	Weight	Arm Circumference	Fat fold at Triceps	FEMALES Height	Weight	Arm Circumference	Fat fold at Triceps
– 1	64.5	7.0	...	...	64.5	7.5	...	...
– 3	76.6	7.7	...	...	76.4	10.9	...	...
– 5	84.1	10.9	12.5	4.8	...	...	...	...
– 10	115.3	20.9	15.0	4.9	100 8	15.5	13.8	7.3
– 15	127.9	27.5	15.9	4.9	130.4	28.2	16.0	6.1
– 25	157.4	50.1	22.5	5 6	147.3	47.8	21.9	9.4
– 35	161.3	55.5	24.2	4.3	151.3	52.6	23 6	11.5
– 45	162.5	61.1	25.7	5.8	149.8	50.4	22.4	8.3
– 55	159.6	56.6	23.6	4.9	150.6	50.4	22.7	7.9
<55	159.2	56.7	23.5	4.7	151.6	52.9	23.9	9.9

Reference: Annual Report, Nutrition Research Laboratories, (1965–66).

TABLE 41

GOITRE INCIDENCE (PERCENTAGE) IN NEFA

Area	Tawang			Dirang			Both Areas		
Sex	M	F	T	M	F	T	M	F	T
Grades									
0	19.0	24.0	53.4	78.0	51.1	66.1	79.9	45.0	63.6
1	5.0	32.0	20.0	1.9	21.0	10.6	2.4	23.8	12.4
2	5.0	28.0	17.7	13.4	10.5	12.2	12.1	14.7	13.3
3	0.0	16.0	8.9	6.7	16.4	11.1	5.6	16.5	10.7
1+2+3	10.0	76.0	46.6	22.0	48.9	33.9	20.1	55.0	36.4

PERCENTAGE INCIDENCE OF ANGULAR STOMATITIS AND CARIES IN NEFA

Age Groups	Sex	0–1	1–5	–15	–25	–35	–45	–55	>55	All ages
Angular Stomatitis	Males	...	8.2	22.6	26.7	25.0	26.1	42.9	20.0	23.3
	Females	...	...	10.5	8.7	16.0	21.4	15.4	...	10.9
	Total	...	6.2	18.0	18.8	18.9	24.3	25.0	7.6	18.0
Caries	Males	25.0	8.3	58.0	60.0	33.3	60.9	85.7	80.0	53.2
	Females	...	25.0	63.1	56.5	60.5	78.6	69.2	50.2	59.6
	Total	14.2	12.5	60.0	58.4	51.3	67.5	75.0	61.2	56.2

Reference : Annual Report, Nutrition Research Laboratories (1965 – 66)

TABLE 42

MEASUREMENTS OF ONGE TRIBALS BY AGE AND SEX

Age		Height	Weight	Head Circum-ference	Chest Circum-ference	Bicristal diameter	Biacromial diameter	Arm Circum-ference	Calf Circum-ference	Fat Fold at Triceps	Fat Fold at Calf
0–6 months	M	...	...	...	...	...	...	...	...	...	...
	F	46.3	2.6	...	...	...	...	...	...	...	...
6M–12M	M	69.0	7.1	...	...	...	...	...	...	...	...
	F	63.7	6.0	...	...	...	...	...	...	...	...
1–3 Yrs.	M	83.5	10.8	...	...	...	...	...	...	...	...
	F	78.7	10.5	...	...	...	...	...	...	...	...
3–5 Yrs.	M	...	...	...	...	...	...	...	...	...	...
	F	94.9	13.3	...	...	...	...	...	...	...	...
5–10 Yrs.	M	118.2	19.6	...	...	...	...	...	...	...	...
	F	117.8	19.7	...	...	...	...	...	...	...	...
10–15 Yrs.	M	128.9	26.7	...	...	...	...	...	...	...	...
	F	131.1	28.1	...	...	...	...	...	...	...	...
5–15 Yrs.	M	...	...	49.5	62.2	18.5	25.6	17.2	24.3	6.3	10.(
	F	...	...	47.2	58.3	25.7	17.8	16.8	24.0	9.7	9.4
Adults	M	149.8	43.2	...	...	...	...	...	...	...	...
	F	140.4	43.0	...	...	...	...	...	...	...	...
15 ≥	M	...	...	51.2	75.2	22.2	32.9	24.0	29.5	5.9	7.4
	F	...	...	49.5	75.3	21.4	29.1	24.9	29.7	11.6	11.6

Reference: *Medical Survey of Onge trbe in the Andaman aud Nicobar islands* (1969). A report submitted by the team from Nutrition Research Laboratories.

TABLE 43

HAEMOGLOBIN AND SERUM IRON VALUES IN ONGES

Subjects	No.	Hbg%	Hbg < 11.OG%	Serum Iron μg / 100 ml
Adult Males	24	14.91	1	83.8
Adult Females	11	13.87	1	76.0
Children 5–15 Yrs.	7	11.86	2	76.0
Children < 5 Years	1	7.50	1	...
Local Labourers Adult Males	58	14.85	4	...

Reference: *Medical Survey of Onge tribe in the Andaman and Nicobar islands* (1969) A report submitted by the team from Nutrition Research Laboratories.

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